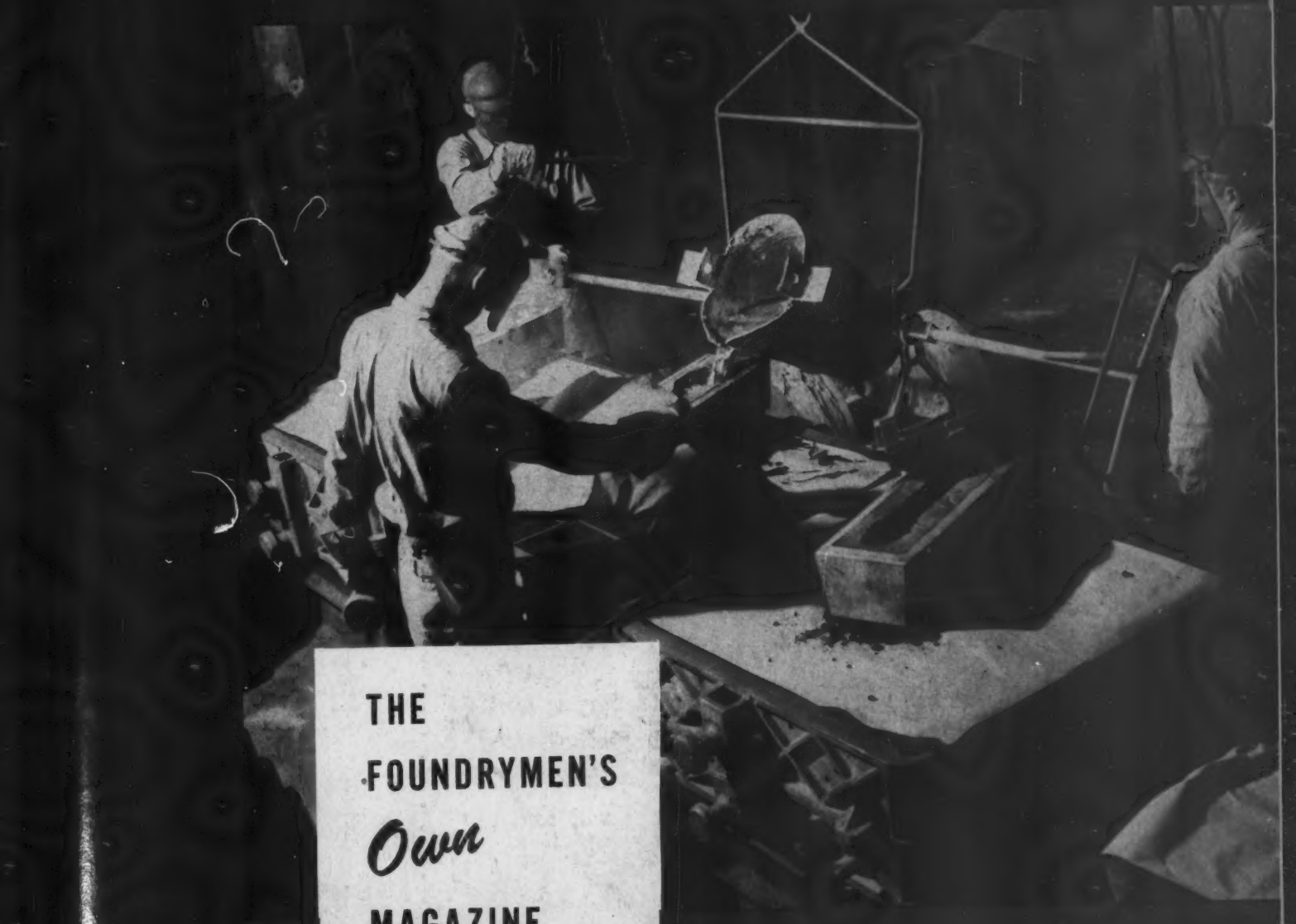
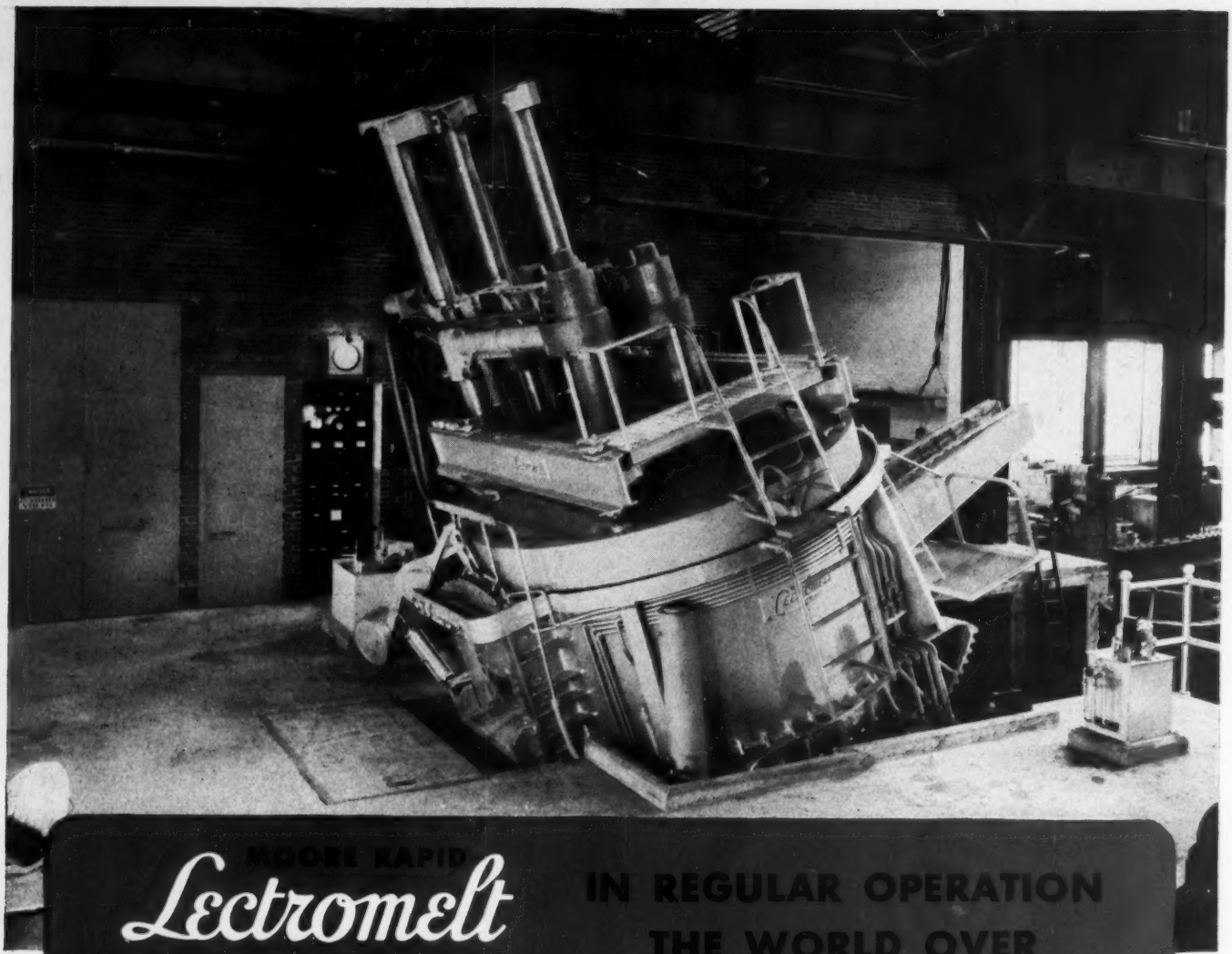
JANUARY
1948

American Foundryman



THE
FOUNDRYMEN'S
Own
MAGAZINE



MOORE RAPID

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More than *one million kilowatts* of Lectromelt furnace capacity is now in regular operation in all parts of the world—eloquent testimony of Lectromelt's superiority in the metal melting field. Over a thousand different Lectromelt users are daily receiving the benefits of this efficient, economical performance.

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PARTICIPATING IN A. F. A. COMMITTEE WORK

DURING THESE DAYS of material difficulties, real or fancied, it becomes very important that every foundryman reappraise his position with respect to quality and prepare himself and his organization to take advantage of the fundamental data offered in the technical literature.

The various sub-committees of the A.F.A. Gray Iron Division have been and are very active in the dissemination of data useful to all makers of gray iron. The ANALYSIS OF CASTING DEFECTS book is the most recent release; the CUPOLA HANDBOOK and others came earlier. The committees responsible for these publications do not consider their task finished, but rather are organizing anew to fill the gaps disclosed by their original activities.

One of the best ways for any organization to acquire the new knowledge, and make it applicable to its own needs, is to have a representative on one of the active committees, or to invite such a committee to co-operate with the technical staff of the operating company.

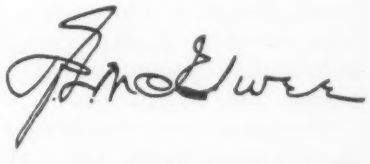
The most important effect of the application of newly acquired basic knowledge is the whetting of the appetite for studies of other fields, equally important, but unexplored. To those who work and contribute to committee assignments the vista of future research and improvement of practice is an ever expanding challenge. Our meager knowledge of fundamentals of gray iron metallurgy is at once apparent to any serious worker in this field.

The A.F.A. Gray Iron Division has need for many serious workers, for the committees already organized as well as for those areas not at present assigned to committee personnel. Unfortunately, many of those best qualified technically and with available facilities find it necessary or convenient to answer with a negative reply based on being "too busy."

It should be apparent to those who are fearful of time involved that the repetition of names in committees, year after year, is in itself an indication of the personal gain and pleasure these faithful ones find in co-operating with others and contributing to the general knowledge of a branch of the castings industry.

To those who intend to do it "some day" let me add the doctor's admonition which is especially appropriate, "never chew your pills." To those who do not know where to start, let me say that the important thing is to get started, even in a small way, and new avenues will open surprisingly fast.

To management, the training and the facilities for consultation with colleagues should be sufficient incentive to request and require of your staff activities for the common good which will repay you out of all proportion to your individual outlay for such participation.



R. G. MCELWEE, *Chairman*
A.F.A. Gray Iron Division

R. G. MCELWEE is a native of Williamsport, Pa. Identified with the foundry industry for over 30 years, he began his career with Muncie Foundry & Machine Co., Muncie, Ind., as chief inspector. At present he is manager, iron foundry division, with the Vanadium Corp. of America, Detroit. He also is currently serving as chairman of the A.F.A. Cupola Research Committee, and will receive the John A. Penton medal for 1948.

52nd MEETING TO FEATURE THE TECHNOLOGY OF TODAY

THE UNUSUALLY large number of applications for exhibit space received prior to first assignments of space December 15 indicates the increasing recognition by manufacturers of the importance of the foundry market and of participation in the 1948 A.F.A. Foundry Show, to be held in conjunction with the 52nd Annual Meeting at Philadelphia next May 3-7.

Among those who will exhibit at Philadelphia are many firms that have never before displayed their products to the castings field, and many others that have not taken part in A.F.A. shows for many years.

With registration at the five-day Foundry Congress and Show expected to surpass the all-time high 18,000 of the 1946 Golden Jubilee meeting in Cleveland, producers of equipment and supplies applicable to the foundry field are making representation before this world-wide castings industry audience an integral part of their sales programs.

New and improved products which had not been developed to the display stage in 1946 will be ready this year, and foundry executives and technologists are eager to study them as production tools under present conditions of shortages in raw materials and trained personnel.

Exhibit information, floor plans and space applications, were distributed early in November. Requests for further details should be addressed to Alfred A. Hilbron, Convention and Exhibit Manager, American Foundrymen's Association, 222 W. Adams St., Chicago 6.

Housing Bureau Assigns Hotel Rooms

As in the past several years, hotel accommodations will be assigned by a housing bureau. Applications were mailed out early this month. Requests for hotel rooms should be addressed to the A.F.A. Housing Bureau, which has headquarters in the offices of the Philadelphia Convention and Visitors' Bureau, 17th and Samson Sts., Philadelphia.

This year, the exhibit halls will open at 9:00 am daily, except Wednesday, May 5th, the day of the Annual Business Meeting, when they will open at 11:00 am. They will remain open until 9:00 pm, Philadelphia Day, Tuesday; until 5:30 pm, Monday, Wednesday and Thursday, and 4:30 Friday.

The technical program to be presented in specific and general interest, round table and shop course sessions by A.F.A. Divisions and General Interest Committees, will feature the up-to-the-minute data on production and control techniques that are of the keenest interest to foundrymen faced with the problems of maintaining high-level castings production under present conditions.

Sessions have been so scheduled that delegates will be able to attend the maximum number in their field of interest in the minimum number of days (see tentative program on adjoining page).

Aluminum and magnesium, brass and bronze, malleable, and educational topics will be covered Monday and Tuesday, May 3rd and 4th; those of the Pattern Division, Tuesday and Wednesday, and of the Sand Division, except for the shop course series, Wednesday, Thursday.

Gray Iron and Steel Division meetings will be held Thursday and Friday, except for the Gray Iron Shop Course sessions.

Shop Courses Run Monday to Thursday

The popular, informal Gray Iron and Sand Shop courses will be presented at 8:00 pm daily, Monday through Thursday. Sand meetings will cover recommended practices for gray iron, malleable, steel and non-ferrous plants. Gray iron topics include the relationship of cupola coke to carbon control; the effect of cupola blast, and factors affecting fluidity of cast iron.

Educational sessions will be of unusual interest to all delegates this year, in view of recent steps taken by the castings industry to establish improved facilities for the training of foundry engineers and technologists. The A.F.A. Educational Division will sponsor a technical session Monday morning; the annual Round Table Dinner the same day; the Engineering School Graduates Luncheon, Wednesday, and the division business meeting.

A six-man speakers panel will be featured at Monday's session, devoted to problems related to the recruiting and training of foundry personnel. The speakers will answer questions submitted by chapter educational committees and other groups, as well as those raised from the floor during the discussions.

Another quiz-type program will be that sponsored by the A.F.A. Foundry Cost Committee. Members of the group will discuss questions on specific cost problems of general interest to the field, concerning methods of cost accounting, distribution of costs, or application of cost accounting data.

Written questions will be solicited by the committee (see page 37). Those received, together with the answers prepared by committee members, will be dis-

tributed at the meeting, and such as are considered appropriate and of sufficiently broad interest will be discussed at Thursday afternoon's meeting.

If necessary to permit dealing fully with all the queries considered of particular interest to foundrymen throughout the industry, the committee will sponsor a second Convention session.

With the present growing emphasis on foundry mechanization, delegates to the 52nd Annual Meeting are expected to find the meeting of the A.F.A. Plant and Plant Equipment Committee, Tuesday evening, especially timely and interesting. The topic will be innovations in foundry mechanization, with particular reference to small plants.

Progress Report on Heat Transfer

The A.F.A. Heat Transfer Committee will present a progress report comprising four technical papers, Tuesday afternoon; the Refractories Committee, meeting Wednesday afternoon and evening, will include another of the popular question-and-answer panels on its program; and the Job Evaluation and Time Study Committee will emphasize time study of foundry operations at sessions Thursday morning and afternoon.

IBF and Australian Exchange Papers

Other technical program highlights include the exchange papers of the Institute of British Foundrymen and the Institute of Australian Foundrymen, and the special lecture series sponsored by the A.F.A. Annual Lecture Committee.

E. Longden of P. R. Jackson & Co. Ltd., Manchester, England, will present the IBF paper on "Contraction and Distortion in Ferrous Casting." R. W. K. Honeycombe is the IAF author and his paper will deal with copper lead alloys. He recently won a scholarship to attend Cambridge University.

Five lectures on quality control test procedure com-

Tentative Schedule of Sessions

1948 Foundry Congress and Show

Philadelphia—May 3-7

Monday, May 3

8:30 am — Exhibits Open
Registration

10:00 am — Technical Sessions
(a) Educational
(b) Aluminum and Magnesium

12 noon — Brass and Bronze Round Table Luncheon

2:00 pm — Technical Sessions
(a) Aluminum and Magnesium
(b) Malleable

4:00 pm — Technical Session
(a) Brass and Bronze

6:30 pm — Educational Dinner

8:00 pm — Technical Sessions
(a) Gray Iron Shop Course
(b) Sand Shop Course

Tuesday, May 4

10:00 am — Technical Sessions
(a) Aluminum and Magnesium
(b) Malleable

12 noon — Aluminum and Magnesium Round Table Luncheon
Malleable Round Table Luncheon

2:00 pm to 9:00 pm — Philadelphia Day

2:00 pm — Technical Sessions
(a) Brass and Bronze
(b) Pattern
(c) Heat Transfer

7:00 pm — Chapter Officers and Directors Dinner

8:00 pm — Technical Sessions
(a) Plant and Plant Equipment
(b) Gray Iron Shop Course
(c) Sand Shop Course

Wednesday, May 5

9:30 am — Annual Business Meeting

10:15 am — Charles Edgar Hoyt Lecture

12 noon — Pattern Round Table Luncheon
Engineering School Graduates Luncheon

2:00 pm — Technical Session
(a) Refractories

4:00 pm — Technical Session
(a) Sand

7:00 pm — Canadian Members Dinner

8:00 pm — Technical Sessions
(a) Gray Iron Shop Course
(b) Sand Shop Course
(c) Refractories

Thursday, May 6

10:00 am — Technical Sessions
(a) Job Evaluation and Time Study
(b) Gray Iron
(c) Steel

12 noon — Steel Round Table Luncheon

2:00 pm — Technical Sessions
(a) Cost
(b) Gray Iron

4:00 pm — Technical Sessions
(a) Job Evaluation and Time Study
(b) Sand

8:00 pm — Technical Sessions
(a) Gray Iron Shop Course
(b) Sand Shop Course

Friday, May 7

10:00 am — Technical Sessions
(a) Gray Iron
(b) Steel

2:00 pm — Technical Sessions
(a) Gray Iron
(b) Steel

7:00 pm — ANNUAL BANQUET

The Franklin Institute, Philadelphia, where A.F.A. held its first annual convention in 1896.

prise the special series. They will cover recommended practices for brass, bronze and nickel alloys; gray iron; aluminum and magnesium; malleable iron, and steel.

Speakers are, respectively, William Romanoff, H. Kramer & Co., Chicago; F. J. Walls, International Nickel Co., Detroit; E. V. Blackmun, Aluminum Co. of America, Cleveland; M. O. Booth, Central Foundry Div., General Motors Corp., Saginaw, Mich., and John Juppenlatz, Lebanon Steel Foundry, Lebanon, Pa.

In view of the difficulties experienced by many foundries in maintaining quality despite today's shortages and substitutions in vital raw materials, it is anticipated that attendance at the series will be heavy.

Annual Lecture on Magnesium

Featured on the Aluminum and Magnesium Division program are such topics as the aging of a magnesium casting alloy, stress analysis of light metals castings, and an analysis of an aluminum casting alloy series. Also of particular interest to light metal foundrymen is the Charles Edgar Hoyt Annual Lecture on "The Control of Grain Size in Magnesium Castings."

Charles E. Nelson, technical director of the magnesium division of Dow Chemical Co., Midland, Mich., will present the Hoyt lecture at the Annual Business Meeting.

Highlight of the business meeting will be the Annual Election of A.F.A. Officers and Directors. First-place winners in the National Apprentice Contest, who will be guests of the Association at the Convention, will receive their prizes and certificates at the business session from A.F.A. President Max Kuniansky, Lynchburg Foundry Co., Lynchburg, Va.

A.F.A. Gold Medals and Honorary Life Memberships are to be presented at the Annual Banquet, which will climax the five-day meeting Friday (see Page 26).

Other traditional events, the Chapter Officers and Directors Dinner and the annual gathering of Canadian foundrymen, are scheduled for Tuesday and Wednesday, respectively. The Dominion A.F.A. members will have a dinner meeting, rather than the customary luncheon, this year, and a third Canadian chapter—the British Columbia group, approved at the 51st Annual Convention in Detroit—will be represented with the Eastern Canada and Newfoundland and the Ontario chapters.

At least five new chapters, organized since the Detroit meeting, will be represented at the Chapter Officers and Directors Dinner: in addition to British Columbia, the Central Michigan, Eastern New York, and Missouri School of Mines and Ohio State University student groups.

General chairman and A.F.A. National Director John M. Robb, Jr., Hickman, Williams & Co., Inc., Philadelphia, has organized a number of committees which will assume responsibility for the various activities of the 52nd Annual Meeting. The committees and personnel appointed follow.

General Committee on Arrangements

Chairman: John M. Robb, Jr.; *Co-Chairman:* W. B. Morley, Olney Foundry Div., Link-Belt Co., Philadelphia; and *Secretary-Treasurer* R. J. Keeley, Ajax Metal Co., Philadelphia.

Members: B. A. Miller, Baldwin Locomotive Works, Philadelphia; W. B. Wilkins, American Manganese Bronze Co., Philadelphia; S. C. Kirn, M. L. Kirn & Bro., Philadelphia; H. L. McClees, Crucible Steel Casting Co., Lansdowne; H. P. Good, Textile Machine Works, Reading; George F. Pettinos, Jr., George F. Pettinos, Inc., Philadelphia; and T. J. Gerwig, Republic Steel Corp., Philadelphia.

Ladies' Entertainment Committee

Chairman: H. J. Williams, New Jersey Silica Sand Co., Millville, N.J., and *Co-Chairman:* Mrs. H. J. Williams.

Members: Mrs. C. W. Mooney, Jr.; Mrs. M. B. Valentine; Miss Irene Gocher; Mrs. W. D. Bryden; Miss Dorothea M. Thum; Mrs. C. W. Thompson; Mrs. E. C. Benkert; and Mrs. K. S. Matz.

Reception Committee

Chairman: H. E. Mandel, Pennsylvania Foundry Supply & Sand Co., Philadelphia; and *Co-Chairman:* A. A. Thum, Palmyra Foundry Co., Palmyra, N.J.

Members: F. L. Mattson, Hickman, Williams & Co.; J. B. Hoot, Carson, Marshall Co., Inc., Philadelphia; A. H. Scherer, Acme Brass & Bronze Foundry, Inc., Philadelphia; G. H. Bradshaw, Philadelphia Navy Yard, Philadelphia; J. E. Finengan, Colonial Smelting & Refining Co., Columbia; M. Calciano, Chas. Mousley's Sons, Philadelphia; Wm. M. Davies, Reading Foundry & Supply Co., Reading; H. Lloyd Hess, Lancaster Malleable Castings Co., Lancaster; C. H. Meminger, Lancaster Iron Works, Inc., Lancaster; Werner Finster, American Chain & Cable Co., Inc., Reading; H. D. Horton, Ingersoll Rand Co., Phillipsburg, N.J.; Robert Latham, Bethlehem Steel Co., Bethlehem; N. H. Oliver, Downington Mfg. Co., Downington; John Juppenlatz, Lebanon Steel Foundry, Lebanon; S. G. Flagg, III, Stanley G. Flagg & Co., Philadelphia; J. W. March, Camden Foundry Co., Camden, N.J.; P. B. Harner, Union Mfg. Co., Inc., Boyertown; W. E. Jones, National Engineering Co., Drexel Hill; C. B. Somers, Whithead Bros. Co., New York; J. W. Mentzer, Taggart & Co., Philadelphia; H. D. Ritter, Sanitary Co. of America, Linfield; J. N. Lanning, Perseverance Iron Foundry, Inc., Philadelphia; C. D. Hamburg, Bonair Foundry Co., Philadelphia; E. C. Benkert, Fairmount Foundry, Inc., Philadelphia; R. E. Teach, Werner G. Smith Co., Haverford; J. J. Edmiston, U. S. Graphite Co., Upper Darby; H. S. Enderlein, H. G. Enderlein Co., Philadelphia; C. P. Speitel, Carbon Malleable Casting Co., Lancaster; Wm. H. Cantwell, Eastern Malleable Iron Co., Wilmington, Del.; N. T. Booth, Deemer Steel Casting Co., New Castle, Del., and J. F. McKinney, Sun Shipbuilding & Dry Dock Co., Chester.

Entertainment Committee

Chairman: W. J. Gallana, Rogers Brown Lavino Co., Philadelphia; and *Co-Chairman:* Louis Dill, George F. Pettinos, Inc., Philadelphia.

Members: Wm. Thawley, Philadelphia Non-Ferrous Foundry, Inc., Philadelphia; S. C. Kirn, M. L. Kirn & Bro., Philadelphia; A. C. Gocher, Fletcher Works, Inc., Philadelphia; H. V. Witherington, H. W. Butterworth & Sons Co., Philadelphia; H. E. Mandel, Pennsylvania Foundry Supply & Sand Co., Philadelphia; Paul Brooks, Debevoise Anderson Co., Inc., Philadelphia; L. E. Bilger, Keystone Grey-Iron Foundry Co., Pottstown; J. A. Keeth, Penn Steel Castings Co., Chester; G. G. Bewley, Bethlehem Steel Co., Philadelphia; H. N. Albright, Columbia Malleable Castings Corp., Columbia; D. G. Burkert, Eastern Foundry Co., Boyertown; G. L. Coppage, Pusey & Jones Corp., Wilmington, Del.; T. A. Walker, Jr., Warren Foundry & Pipe Corp., Phillipsburg, N.J.; M. G. Moore, Jr., Empire Steel Castings, Inc., Reading; R. S. Munson, Atlantic Steel Castings Co., Chester; K. S. Matz, North Bros. Mfg. Co., Philadelphia; N. R. Klein, Caloric Stove Corp., Topton; F. E. Schumann, Lehigh Foundries, Inc., Easton; Wm. J. Johnson, Birdsboro Steel Foundry & Machine Co., Birdsboro; T. F. Miller, Schneider Bowman Co., Inc., Philadelphia; George Schmidt, Philadelphia Bronze & Brass Corp., Philadelphia; and Robert Fretch, Union Bronze Co., Inc., Reading.

Publicity and Philadelphia Day Committee

Chairman: J. L. Furey, Swan-Finch Oil Corp., Philadelphia; and *Co-Chairman:* A. J. Saute, American Engineering Co., Philadelphia.

Members: R. M. Anson, Crucible Steel Castings Co., Lansdowne; G. H. Bradshaw, Philadelphia Navy Yard, Philadelphia; E. F. Nunemacher, Jr., Selas Corp. of America, Philadelphia; R. R. Belleville, Jos. Dixon Crucible Co., Philadelphia; H. L. Henszey, Carborundum Co., Philadelphia; G. R. Sullivan, Hanna Furnace Co., Philadelphia; H. J. Winters, J. S. McCormick Co., Philadelphia; and H. E. Schellhase, Pangborn Corp., Wallingford.

Plant Visitation Committee

Chairman: C. W. Mooney, Jr., Olney Foundry Div., Link-Belt Co., Philadelphia; and *Co-Chairman:* Edward Berry, Dodge Steel Co., Philadelphia.

Members: H. J. Johnston, General Steel Castings Corp., Eddystone; W. A. Brown, Florence Pipe Foundry & Machine Co., Florence, N.J.; H. W. Stuart, United States Pipe & Foundry Co., Burlington, N.J.; G. H. Bradshaw, Philadelphia Navy Yard, Philadelphia; J. S. Csaklos, Crucible Steel Castings Co., Lansdowne; W. D. Bryden, Philadelphia Bronze & Brass Corp., Philadelphia; R. E. Schmidt, Rolle Casting Co., Inc., Philadelphia; and R. M. Carrigan, North American Smelting Co., Philadelphia.

DO YOU HAVE PROBLEMS?

All of us have more foundry problems than we have time or facilities to solve. You can help yourself and the foundry industry by outlining your foundry research problems for the College Research Projects Committee of the Educational Division.

This committee is stimulating foundry research in engineering schools by preparing and distributing a booklet outlining foundry research problems. This work is entirely separate from research carried on under division research committees and A.F.A. sponsorship is not contemplated.

Prepare your suggestions for one or more research projects according to the outline: discussion; value of project; suggested procedures; and facilities needed.

Send your college research project suggestions to Prof. Richard Schneidewind, Chairman, A.F.A. College Research Projects Committee, Dept. of Chemical and Metallurgical Engineering, University of Michigan, Ann Arbor.

A.F.A. award winners

Max Kuniansky

P. E. Rentschler

E. H. Ballard

R. G. McElwee

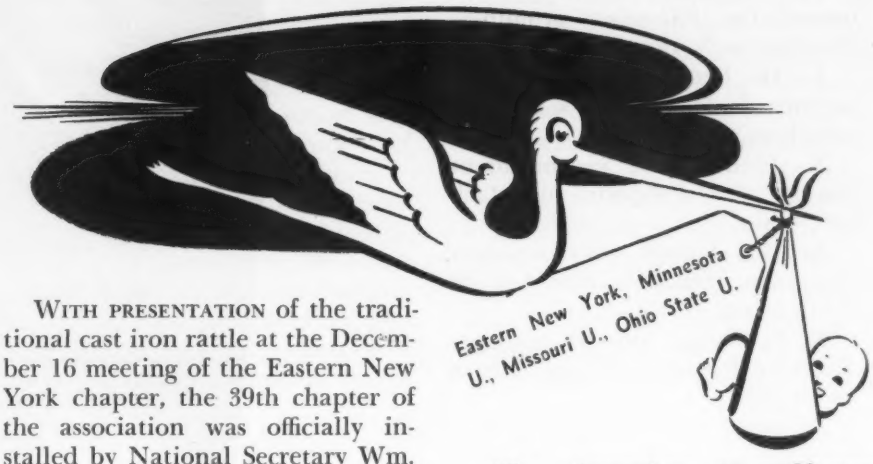
IN ACCORDANCE with the recommendation of the Board of Awards of the American Foundrymen's Association, three medals recognizing achievement and service to the foundry industry will be presented at the Association's annual banquet which will be held on Friday evening, May 7, in connection with the annual convention and exhibition.

This one of the Association activities dates back to the 1920 Columbus, Ohio, convention when an announcement was made that four prominent and veteran members of the Association had each donated a sum of money, the income to provide an award to be conferred on certain individuals who, in the opinion of the board of awards, had made some notable contributions to the progress of the industry during the preceding year. Donors of the fund included J. M. Whiting, W. S. Seaman, John A. Penton and W. H. McFadden. The fifth A.F.A. medal, the Peter L. Simpson award, was initiated in 1946, and was founded by H. S. Simpson.

At the December 15 Board of Awards meeting, A.F.A. Past President E. H. Ballard, Swampscott, Mass., was selected as the winner of the W. H. McFadden medal. Recipient of the Peter L. Simpson medal will be P. E. Rentschler, president, Hamilton Foundry & Machine Co., Hamilton, Ohio. The John A. Penton award is to be given to R. G. McElwee, manager, iron foundry div., Vanadium Corp. of America, Detroit.

An honorary life membership in A.F.A. will also be awarded to A.F.A. President Max Kuniansky, Lynchburg Foundry Co., Lynchburg, Va.

IT'S QUADRUPLETS!



WITH PRESENTATION of the traditional cast iron rattle at the December 16 meeting of the Eastern New York chapter, the 39th chapter of the association was officially installed by National Secretary Wm. W. Maloney, Chicago. The rattle, long emblematic of each "baby" chapter, was formally presented to the Chapter Chairman C. E. Killmer, Sr., Swan-Finch Oil Corp., Albany.

In making the presentation, Secretary Maloney urged all members to give their Officers and Directors full support and to take advantage of the opportunity to advance the foundry industry in eastern New York. Chairman Killmer's response pledged the Chapter's Officers and Directors to conduct the group activities in accordance with the objects of the Association, and for maximum benefit of all members.

Chapter Benefits

Following the presentation, National Director H. H. Judson, Worcester, Mass., spoke briefly on the advantages of membership and chapter work, recounting the benefits derived by the Central New York chapter, with which he formerly was affiliated.

Technical speaker of the evening was Pat Dwyer, *The Foundry,* Cleveland, who was well received for his talk on "Gates and Risers." Mr. Dwyer illustrated, with slides, the many types of gating used by foundrymen and described the advantages and disadvantages of each type, calling on his long experience as a practical foundryman in doing so. He urged foundry supervision to pay more attention to the gating of various castings, especially in jobbing shops, emphasizing the point that each separate gating method had been developed by practical foundrymen over the years in casting many types and shapes of products, and with many different materials.

The December 16 "Charter Night" of the new chapter was held at the Circle Inn, just outside Albany, and was attended by some 70 members and guests.

Committee Chairmen

Chairman Killmer has announced committee appointments for the balance of the fiscal year as follows: F. Vergamini, Ludlow Valve Mfg. Co., Troy, New York, *Chairman Program Committee;* A. Hopson, Ramsey Chain Co., Inc., Albany, *Chairman Membership and Attendance Committee,* and C. F. Blumenauer, Albany Castings Co., Voorheesville, N.Y., *Chairman Publicity Committee.*

A petition has been received from the University of Minnesota Student chapter, Minneapolis, for revival of the group that has been inactive since the beginning of World War II. This organization is the first student chapter of A.F.A. and was set-up with the cooperation of the A.F.A. Twin City chapter in 1941.

James H. Anderson, instructor in mechanical engineering, has been named faculty advisor and Carter DeLaittre, Minneapolis Electric Steel Castings Co., Minneapolis, will be industrial advisor.

H. F. Scobie, A.F.A. Educational Assistant, was instrumental in founding the original chapter at the university before the war when he was instructor of foundry practice at the institution.

At a recent meeting the following were elected to serve as officers: *Chairman,* John Hermanson; *Vice-Chairman,* Lyde M. Irwin; *Secretary,* Harvey Sauby; *Treasurer,* Ted Swanson; *Program Chairman,* Richard Fisher; and *Publicity Chairman,* David Huch.

Other members signing the chapter petition were: Donald J. Woodhouse, H. A. Widell, R. C. Bradley, Herman Rischall, H. U. Bruhjell, R. L. Zak, F. J. Green, Howard Tomasko, C. E. Dekko, W. J. Preble and H. R. Carlsen.

Seventeen student members of A.F.A. at the Missouri School of Mines and Metallurgy, Rolla, have organized the second student chapter of A.F.A. The petition is the result of the combined efforts of Professor D. S. Eppelsheimer, associate professor of metallurgical engineering, and H. F. Scobie. Professor Eppelsheimer will also act as faculty advisor.

The St. Louis District chapter is cooperating with the student group and has appointed George E. Mellow, Liberty Foundry Co., St. Louis, as industrial advisor.

Students signing the petition were: J. E. Reynolds, Jr.; E. G. Littea, Stanley Zirinsky, J. H. Cox, E. E. Cornelius, G. H. Moline, L. H. Markway, J. W. Mitchell, R. R. Peiman, D. H. Burgham, G. J. Carron, R. J. Niewoehner, Ken Niewoehner, Robert Rock, J. G. Reilly, E. L. Brundige, and Robert L. Williamson.

The officers of the Missouri chapter are as follows: James E. Reynolds, Jr., *Chairman;* Gordon Moline, *Vice-Chairman;* John G. Reilly, *Secretary;* Stanley Zirinsky, *Treasurer;* Edwin Cornelius, *Program Chairman,* and John W. Mitchell, *Publicity Chairman.*

Third Student Group

Ohio State University, Columbus, is the third group to affiliate as an A.F.A. student chapter. The chapter was organized largely through the efforts of D. C. Williams, assistant professor, industrial engineering department, and former A.F.A. Research Fellow, Sand Research Project, Cornell University, Ithaca, N.Y.

Student chapter officers of the Ohio State group include: William Dundon, *Chairman;* Thomas Dole, *Vice-Chairman;* and Eldon Boner, *Secretary-Treasurer.*

This unit is unique in that it has five industrial advisors; one from each of the five A.F.A. Ohio chapters—Northeastern Ohio, Central

(Concluded on Page 62)

Nominations FOR A.F.A. Officers and Directors

W. B. WALLIS, president, Pittsburgh Lectromelt Furnace Corp., Pittsburgh, Pa., was nominated as President, American Foundrymen's Association, at a meeting of the Nominating Committee held in Chicago, December 16. Mr. Wallis is currently serving as Vice-President of A.F.A. and completed a three-year term as a National Director in 1946.

At the same meeting E. W. Horlebein, president, Gibson & Kirk Co., Baltimore, was nominated as Vice-President, and is now completing a three-year term as a National Director of A.F.A.

Both the President and Vice-President serve one year terms in accordance with the Association's By-laws. The election of new Officers and Directors will take place at the Association's Annual Business Meeting to be held during the 52nd Annual Meeting of A.F.A. in Philadelphia. They will take office immediately following the annual meeting of the Board of Directors, which will be held in July, 1948. Mr. Wallis was nominated to succeed the present A.F.A. President Max Kuniansky, Lynchburg Foundry Co., Lynchburg, Va., who in turn will serve a one year term as a National Director following his retirement from the American Foundrymen's Association Presidency.

The Nominating Committee named the following prominent members as National Directors.

T. H. Benners, Jr., managing partner, T. H. Benners & Co., Birmingham, Ala.

N. J. Dunbeck, vice-president, Eastern Clay Products, Inc., Jackson, Ohio.

A. M. Fulton, vice-president, Northern Malleable Iron Co., St. Paul, Minn.

R. R. Gregg, foundry manager, Reliance Regulator Corp., Alhambra, Calif.

V. E. Zang, vice-president, Steel Castings Div., Unitcast Corp., Toledo, Ohio.

Directors whose terms expire in July, 1948, are: R. R. Gregg, Reliance Regulator Corp., Alhambra, Calif.; E. W. Horlebein, Gibson & Kirk Co., Baltimore, Md.; H. H. Judson, Worcester, Mass.; Jas. H. Smith, Central Foundry Div., General Motors Corp., Saginaw, Mich.; and F. M. Wittlinger, Texas Electric Steel Casting Co., Houston.

By-laws of the Association require that the Secretary shall publish the Nominating Committee report to the membership at least 60 days prior to the date of the Annual

W. B. Wallis

E. W. Horlebein

Max Kuniansky

T. H. Benners, Jr.

Business Meeting. After publication of the Committee's candidates, and at any time 45 days prior to the Annual Business Meeting date, additional nominations may be made by written petition filed with the Secretary of the Association and signed by thirty-five members of good standing in the Association.

Should there be no nominations other than those submitted by the Nominating Committee, the Secretary "shall, at the Annual Business Meeting, cast the unanimous ballot of all members for the election of the candidates named in the report of the Nominating Committee." In the event additional candidates are nominated, the by-laws require that the election shall be by letter ballot.

Past President S. V. Wood, Minneapolis Electric Steel Castings Co., Minneapolis, designated chairman, submitted the report of the 1948 Nominating Committee. Past President F. J. Walls, International Nickel Co., Detroit, was also present. Other members of the group, seven of whom were elected from a list of eligibles submitted by various A.F.A. chapters, in accordance with the by-laws, were L. E. Roby, Peoria Malleable Casting Co., Peoria, Ill.; L. D. Wright, U. S. Radiator Corp., Geneva, N.Y.; Wm. M. Ball, Jr., Edna Brass Div., Magnus Metal Co., Cincinnati; R. F. Lincoln, Russell Lincoln Co., Cleveland; E. M. Strick, Erie Malleable Iron Co., Erie, Pa.; H. B. Hanley, American Laundry Machinery Co., Rochester, N.Y.; and R. R. Haley, Advance Aluminum & Brass Co., Los Angeles.

Chapters represented in the selections of the Nominating Committee include Southern California, Rochester, Northeastern Ohio, Northwestern Pennsylvania, Cincinnati District, Central New York and Central Illinois.

All the new Officers and Directors nominated have played an active part in their respective fields in the foundry industry. Some are widely known for their service on technical committees of the Association, others for chapter work and still others for their continuous support of cooperative activities in the castings field.

Messrs. Benners, Dunbeck, Fulton, Gregg, Horlebein and Zang are all past chairmen of A.F.A. chapters—Birmingham District, Central Ohio, Twin City, Southern California, Chesapeake and Toledo, respectively. They represent nearly all of the phases of the castings industry, namely: supply, sand, malleable, gray iron, non-ferrous and steel.

The activities of President Kuniansky and Vice-President Wallis are many. They have been busy visiting the numerous A.F.A. chapters, attending board meetings and giving chapter talks; consequently nearly all A.F.A. members are familiar with their work.

Other National Directors of the Association are as follows:

(Term expires 1949)

H. G. Lamker, Wright Aeronautical Corp., Woodridge, N.J.

B. L. Simpson, National Engineering Co., Chicago.

N. J. Dunbeck

A. M. Fulton

R. R. Gregg

V. E. Zang

H. A. Deane, Brake Shoe & Castings Div., American Brake Shoe Co., New York.

S. C. Wasson, National Malleable & Steel Castings Co., Chicago.

J. E. Kolb, Caterpillar Tractor Co., Peoria, Ill.

(Term Expires 1950)

E. N. Delahunt, Warden King Ltd., Montreal, Que., Canada.

W. J. MacNeill, G. H. R. Foundry Div., Dayton Malleable Iron Co., Dayton, Ohio.

John M. Robb, Jr., Hickman, Williams & Co., Philadelphia.

A. C. Ziebell, Universal Foundry Co., Oshkosh, Wis.

R. H. McCarroll, Ford Motor Co., Detroit.

MAGNESIUM CASTINGS PRODUCTION AND USE

A. W. Winston
and
M. E. Brooks
The Dow Chemical Co.
Midland, Mich.

MAGNESIUM CASTING ALLOYS are distinguished for their low weight, high strength, easy machinability, and other desirable characteristics. These alloys can be fabricated by any of the commonly used foundry methods, such as green sand, dry sand, plaster, permanent mold, and die casting. Experimental work is now being carried out on centrifugal casting. In general, the casting of magnesium alloys by any of these processes is done in the same manner as used with other common metals except insofar as it is necessary to modify the process or materials used because of the light weight and the thermal and chemical characteristics of magnesium.

The decision as to the casting method to be used for production of a given part will be based on a number of factors. In general, parts of any size and complexity of design can be made by the sand casting method. Fairly simple castings for which the demand is for quantities of over 1,000 pieces may be considered for permanent mold work. Die casting is a possible method for use when the casting sections are relatively thin and uniform, and when the quantity requirements are high, perhaps a minimum of from 1,000 to 5,000 pieces depending on the casting. Usually, production costs are lowest on die castings and highest on sand castings, but this may not be true on certain parts.

Magnesium Alloys

In common with most other pure metals, pure magnesium ordinarily is not considered as a structural material. When alloyed with suitable amounts of aluminum, zinc, and manganese, the properties of the alloys are comparable with those of the aluminum alloys. The total of added metals is usually about 10 per cent and the alloys have a specific gravity of about 1.8, only slightly heavier than the pure metal. The composition, properties, and uses of the common casting alloys are given in Table 1.

Melting of magnesium alloys usually is done with flux protection to prevent oxidation of the molten metal by air. An exception to this is in the die casting operation where clean ingot metal can be melted in a flux-free pot in which the metal is protected with sulphur dioxide. The fluxes used in various melting methods vary somewhat in composition, but they generally contain magnesium and other chlorides as major constituents. These cause the fluxes to be hygroscopic and make necessary some of the precautions observed in the processes used for melting magnesium alloys.

This paper was presented at the Annual Meeting of ASME in Atlantic City, N.J., Dec. 1-5, 1947.

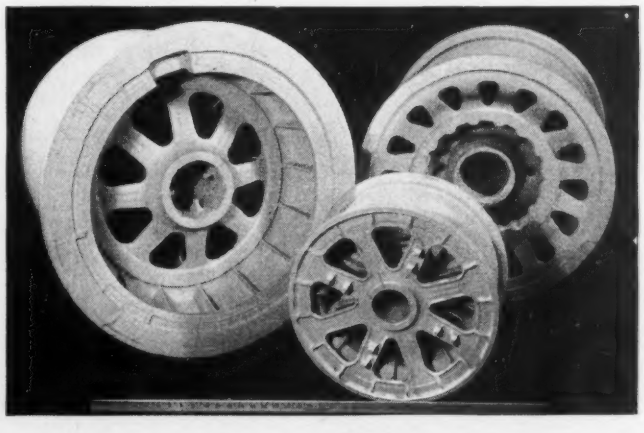
Sand and permanent mold castings are commonly used in both the as-cast and heat-treated conditions. Die-castings are not usually heat treated although in a few cases this has been done. The heat-treating schedule used depends on the service requirements of the castings. Solution heat treatment at 730 to 785 F, depending on composition, gives the maximum toughness and elongation, while aging at 350 to 450 F after solution heat treatment gives maximum hardness and yield strength. Stabilization heat treatment at 500 F gives relief of casting stresses when applied to as-cast parts, and gives approximately the same properties as aging when applied to solution-heat-treated castings.

Heat Treatment

Magnesium alloy castings may be heat treated in either gas-fired or electric furnaces of the circulating atmosphere type. Electric or indirect fired furnaces are preferable for heat treating if the temperatures are above 750 F. To minimize surface oxidation, it is recommended that about 1 per cent sulphur dioxide be maintained in the atmosphere of such furnaces used for solution heat treatment. Magnesium casting alloys are slightly plastic at solution-heat-treating temperatures and so must be placed on the heat-treat rack in such a manner as to receive adequate support.

The same general foundry practice is used in magnesium sand foundries as in those casting other metals. Special features include the flux used for protection during melting, the inhibitor used in the molding sand,

Fig. 2—Magnesium aircraft landing wheel castings. Largest casting weighs about 170 lb.



and the care to avoid turbulence during the flow of metal through the mold passages. Magnesium alloys are light and lose heat rapidly, necessitating generous venting, particularly from thin sections.

Most foundries use an open synthetic molding sand with an A.F.A. permeability of about 100. Natural molding sands with a permeability of about 40 are used to a limited extent and mostly on small castings. The inhibitor used in the molding sand is to prevent reaction between the molten metal and the moist sand. It consists of from 4 to 10 per cent of a mixture of sulphur, boric acid, and a fluoride, usually ammonium silicofluoride. Cores are made from an open sand and most foundries are using an urea-formaldehyde binder

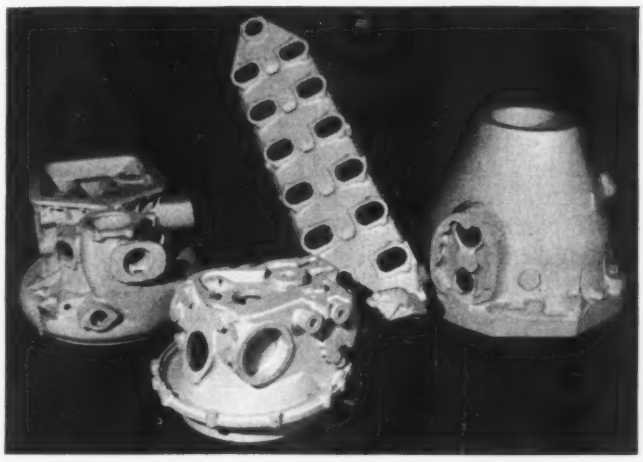


Fig. 3—Magnesium aircraft engine castings. The complicated casting shown at the left weighs 43 lb.

because of easier knockout characteristics. A small amount of sulphur, boric acid, and potassium fluoborate in the core sand protects the casting from oxidation.

Metal for pouring sand castings is melted and cast from crucibles made of welded steel plate. These crucibles are usually spray coated with aluminum to minimize external scaling. Using flux for protection, the metal is either melted in a large premelt unit from which it is poured into the casting crucibles or is melted directly in the crucibles. After melting, the metal is refined by stirring with crucible flux or by bubbling chlorine gas through the melt at about 1350 F. It is then given a grain refining treatment and cast at the selected temperature, usually between 1300 and 1550 F (see Fig. 1 on front cover).

Molds for magnesium castings must be so made that turbulence and resistance to metal flow will be avoided. The conventional gating method is to take the metal to the lowest point in the mold, pass it through a skim gate and steel wool filters, and then bring it into the bottom section of the casting, either through a continuous web gate or through a number of small finger gates. A newer and improved method of gating is to place a tube made of the skim gate in a vertical well which is connected to the casting with a continuous slot gate.

Metal is brought into the tube from either the bottom or the top and fills the casting cavity progressively from the bottom up. This method allows the casting to be poured without passing the metal required for the upper part and the risers through the lower part of the casting, and thus avoids heating the sand and creating hot spots which are hard to feed during solidification. The use of this gating method enables sound, clean castings to be made with fewer chills and less riser metal than with the bottom gate method.

Permanent Mold Casting

In considering the suitability of permanent mold casting as a production method, attention should be given to the design of the part, and quantity requirements. The part should be of fairly simple shape, uniform wall thickness, and without undercuts or complicated internal coring. Production runs of 1,000 or more pieces will usually justify this method of casting. Because permanent mold castings can be made to close tolerances and good finish, it frequently will be possible to eliminate or reduce subsequent machining and finishing operations.

The metal for permanent mold casting is either melted directly in the casting pot or, on large operations, in a separate unit and the casting pot serviced with molten metal at the proper temperature. In either case, sufficient flux is kept in the casting pot to main-

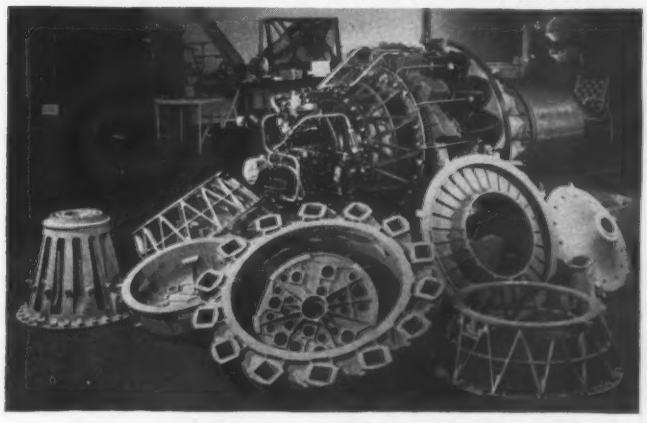


Fig. 4—Turbo-jet engine and principal magnesium castings used in the construction.

Fig. 5 (below)—Miscellaneous magnesium die castings.

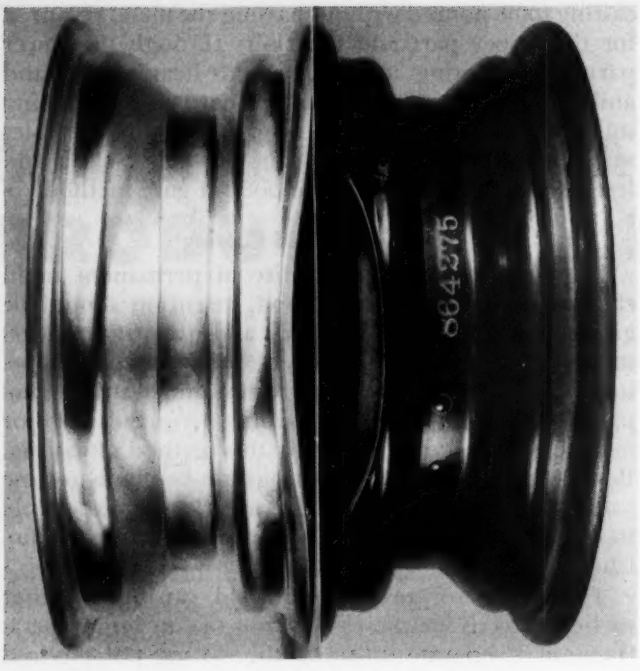


Fig. 6—Cast magnesium automobile wheel (left) weighing 9 lb, and steel wheel weighing 20 lb show results of impact test made by dropping a 200-lb weight onto the rim of each from a height of 26 in.

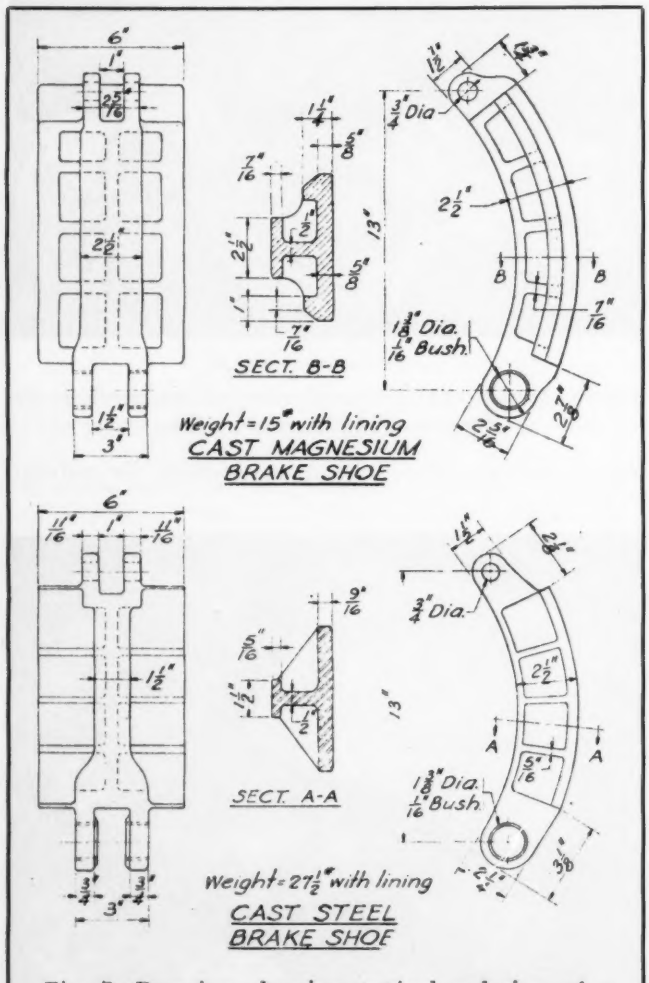


Fig. 7—Drawing showing typical redesign of a steel part as a magnesium casting.

tain the necessary protective film and keep the metal in clean condition. Metal for pouring is dipped from the pot with a bottom-pour ladle designed to prevent flux contamination of the castings.

Molds can be cast from a good quality of high-carbon gray iron. Usually about ½-to 1-in. thickness of metal should be allowed behind the cavity. Cores may be made of sand or steel, depending on the complexity. Ordinary machinery steel will give good service for cores, but it usually is better to use a nickel-free stainless steel if a large number of castings are to be produced. The draft on both mold and core surfaces should be 5 degrees if possible, but 2 or 3 degrees can be used on some castings. Ejector pins usually will be necessary.

Most magnesium alloys are hot-short when first removed from the mold and require careful handling. Mold coating and general practice will be similar to that used for making aluminum castings. The molds may be operated by any one of several methods which will be determined by the production requirements. It may be a simple book mold, or operated manually by a rack and pinion, or an air or hydraulic cylinder.

Most pressure die casting of magnesium is done by the cold-chamber process in high-pressure machines. While pressures as high as 50,000 psi are sometimes used, the average range is from 4,000 to 15,000 psi. The machines generally have die-locking pressures of 400 to 500 tons, but smaller machines are satisfactory for small castings.

Die Casting

Plunger speed and the cycle of die operation are both important in the production of good, uniform die castings. Plunger speeds of 70 to 350 fpm are used, the higher speeds in making thin-walled castings in which it is necessary to fill the die quickly, and the lower speeds in conjunction with higher injection pressures to produce the best quality castings from the standpoint of internal soundness.

Metal handling practice is different for die casting than for the other casting methods. Since small quantities of metal must be dipped from the pot at short time intervals, it is not convenient to use flux for metal protection. The molten metal is held in the casting pot under a protective atmosphere of sulphur dioxide. This atmosphere is held under a cover so placed as to substantially enclose the area over the molten metal. The best metal handling practice is to melt and refine all metal in a separate unit, and to then service the casting pot with clean metal at a constant temperature.

Die casting scrap, because of the contamination introduced, cannot be satisfactorily melted in the casting pot. Clean ingot can be fed into the casting pot, but best results are obtained by premelting all metal. Continuous generation of the protective atmosphere and care in keeping the inside of the casting pot and cover properly cleaned of dross will insure safe and satisfactory operation of this unit.

Dies are made of either carbon tool steel or a tool steel of the 5 per cent chromium—6 per cent tungsten type, depending on whether they are for short or long runs. Alloy steel dies should be heat treated and drawn to a temperature of about 1,100 F.

The metal usually is cast at about 1,200 F, with 1,300 F as the maximum. The dies run at temperatures

TABLE 1—COMPOSITION AND PROPERTIES OF COMMON MAGNESIUM CASTING ALLOYS

Commercial Alloy	ASTM No.	Nominal Composition, per cent				Form	Condition	Typical Mechanical Properties[1]				Remarks
		Al	Mn	Zn	Mg			Tensile Strength psi	Yield[2] Strength psi	Elong. in 2 in. per cent	Brinell Hardness	
H	AZ63	6.0	0.2	3.0	Remainder	Sand and Permanent Mold Castings	As Cast	29,000	14,000	6	50	General purpose casting alloy
							Heat Treated	40,000	14,000	12	55	
							Heat Treated and Aged	40,000	19,000	5	73	
C	AZ92	9.0	0.1	2.0	Remainder	Sand and Permanent Mold Castings	As Cast	24,000	14,000	2	65	Maximum strength and hardness
							Heat Treated	40,000	16,000	10	63	
							Heat Treated and Aged	40,000	23,000	2	84	
R	AZ91	9.0	0.2	0.6	Remainder	Die Castings	As Cast	33,000	22,000	3	60	General purpose alloy

[1] Separately cast ASTM test bars.
[2] Strength at 0.2 per cent deviation from modulus line.

up to about 600 F. They are heated or cooled as needed to maintain the proper temperature. It is important that the correct die and metal temperature be established for each casting and then closely controlled.

Factors in Die Design

Die design will, of course, be dependent on the size and type of casting and the equipment to be used. In general, the design will be similar to that used for aluminum die castings. Generous fillets and careful blending of section changes should be provided. The metal must be brought into the cavity with a minimum of turbulence and with adequate venting. The flowing of large amounts of metal over small die areas should be avoided.

The outstanding characteristic of magnesium is, of course, its remarkably light weight, which is only one quarter that of iron and but two thirds that of aluminum, its companion light metal. The availability of these light and strong structural materials made possible the unprecedented production of powerful aircraft and airborne equipment.

Use of magnesium castings in a wide variety of military applications thoroughly established them as structural materials capable of withstanding the most severe conditions of service. Although the applications now developing are different, service records have been built up which can give designers confidence in the expected performance of the material.

Magnesium alloy castings possess many properties which make them desirable for use in a wide range of applications. The more important properties of interest to the designer may be listed as: (1) High strength-weight ratio; (2) easy machinability; (3) nonmagnetic; (4) nonsparking; (5) stability under most conditions of use.

Properties and Applications

Composition and properties of the usual cast magnesium alloys are given in Table 1. In combination with the low specific gravity of about 1.8, these properties provide the highest strength-weight ratio of the common casting metals. The compositions listed have proved satisfactory for all ordinary operating conditions. However, for stressed applications to operate at temperatures near 400 F or higher, alloys with higher strength retention have been developed. These contain cerium in amounts up to 6 per cent, and may

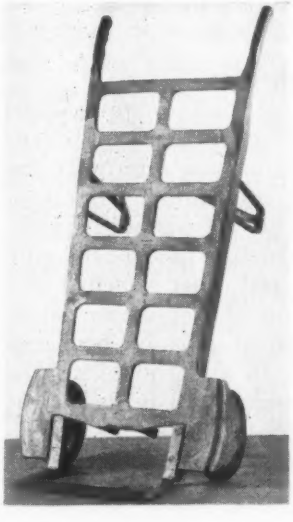


Fig. 8—Cast heavy duty magnesium hand truck.

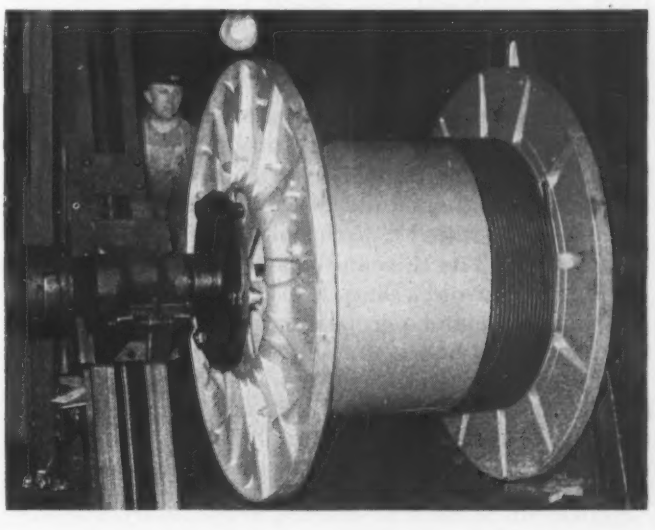


Fig. 9 (right)—Experimental magnesium cable reel undergoing tests.

prove useful for increasing design requirements in turbo-jet engines and pistons for internal combustion engines.

An important characteristic of magnesium castings is their easy machinability, which is rated as superior to that of any other metal. This frequently is a deciding factor in choosing magnesium, as the finished cost of the article may be lowered by so doing. In one example of a lubricator housing, the machining costs were reduced 60 per cent below those for cast iron, and the total final cost was 22 per cent less.

The nonsparking and nonmagnetic properties occasionally have proved useful in special applications. The stability of magnesium is now well established through many exposure-test programs and through the successful experience with thousands of military parts during the war. If reasonable care is exercised in choice of application and in applying ordinary protective measures, satisfactory service will be observed.

Fig. 10—Textile warp beam using 13 in. diameter die cast magnesium flanges.

Design of magnesium alloy castings usually is about the same as for other castings. While good design features are important with magnesium, they really are only those which should be used with all cast materials. To prevent stress concentration leading to fatigue failure, sharp internal corners, gouges in surfaces and other irregularities in stressed areas should be avoided.

Ample fillets should be used around bosses, but not to the extent that the mass is such as to cause draws and cracks. Bosses should be located so that they can be risered or chilled to secure maximum soundness if it is desired. The thin and heavy sections must be so blended as to avoid a sharp transition line. Wall thicknesses in sand and permanent mold castings preferably should not be less than $\frac{3}{16}$ in., but may be $\frac{5}{32}$ in. in limited areas. In die castings, walls may go down to 0.050 in. Additional details of design are available in technical literature and manufacturers' publications.

A practice which will improve the quality and lower the cost of producing castings is for the engineer and the foundryman to get together early in the development of the casting design. When this is done, the most castable design can be developed and the foundry will not need to spend excessive time and labor to work out a special foundry practice. The desirability of early and continued cooperation between these two groups cannot be emphasized too strongly.

Used in Aircraft

As expected, the greatest wartime use for magnesium castings was in aircraft. Fortunately, sand-cast magnesium landing wheels and engine parts were well developed during the "thirties" and it was possible to incorporate them into new military designs with adequate assurance of performance. Except for amphibian use, practically all landing wheels were finally being made in magnesium (Fig. 2). With improved fabrication techniques, tail wheels and landing wheels for light planes were made from magnesium die castings.

Every principal American aircraft power plant used numerous magnesium sand castings for parts such as the blower and supercharger housings, gear cases, front and rear sections, carbureter bodies, ignition harness, oil sumps, air induction system and numerous small parts and covers (Fig. 3). When the production peak was attained in 1944, a number of these parts were being made as permanent mold castings or die castings. Many of these applications were of critical character and required the utmost in quality and dependability.

Of particular current interest is the extensive use of magnesium parts in turbo-jet engine construction. Main frames and the housing and miscellaneous parts of the air compression system are built almost entirely of magnesium castings (Fig. 4). For example, the famous I-40 engine incorporates 41 castings with a rough weight of 450 lb. It should be noted that, while a standard casting alloy, AZ92, has proved satisfactory for most turbo-jet applications, increasing design requirements for alloys to operate at temperatures up to 600 F can be met by a magnesium alloy containing approximately 6 per cent cerium and designated as E6.

In addition to aircraft wheels and engine uses, numerous magnesium castings were employed as airframe structural parts and in a wide variety of accessories. In the latter field, especially heavy use was made of die castings. One company alone, specializing in the highest quality of aircraft starters, hydraulic systems and control instruments, used approximately 13 million magnesium die castings during the war, convincing proof of their utility (Fig. 5).

Airborne Equipment

All of the foregoing wartime aircraft applications for magnesium castings are being continued in present aircraft manufacture. Of more passing interest to the layman, but undoubtedly of continuing interest to those charged with responsibility for our military development, are the uses of magnesium in airborne military equipment. Gun turrets and other attached ordnance equipment made wide use of magnesium, while increasing use was made of it in air-portable ordnance and construction equipment. In all probability, the latter use will expand into commercial fields for the development of hitherto inaccessible areas.

While the lightness of magnesium is vitally important to the aircraft industry, other transportation

industries are becoming increasingly weight-conscious, as will be quickly evident on glancing through the advertising pages of their trade magazines. The advantages of increased payload are obvious to anyone, of course, and the problem becomes one of how to secure it at a cost low enough to insure operating economy over the life of the equipment. The use of light metals, including magnesium castings, in well-engineered designs is a natural answer.

Magnesium sand-cast wheels for passenger automobiles have been tested successfully by several prominent manufacturers, who report smoother riding, easier steering, and remarkably decreased tire wear. The weight is less than one half that of the steel wheel and the strength and safety factors are as good or better than those of steel (Fig. 6).

Higher cost of magnesium sand castings, however, compared to steel stampings has proved to be a serious obstacle. The solution to this problem may be found in the use of die castings, which can be fabricated more cheaply than sand castings, and experiments are now under way in this direction. Another automobile possibility is the die casting of entire doors, securing lowered fabricating costs, as well as lighter weight, compared to steel. A proved prewar application in passenger cars is the use of hundreds of thousands of die cast magnesium end plates for motors and generators.

Truck and Bus Equipment

In other branches of the transportation industry, sand-cast magnesium brackets, spacers and corner caps have been used in bus and truck construction. Heavy castings have been used for fifth wheels in trailer operation and for the landing gear supporting the front end of the trailer. Die cast bus seat frames are being developed, another example of combining a weight saving with lower fabricating costs, compared to the conventional sheet metal assembly.

Sand-cast truck and bus wheels have long been used in England and other European countries and are currently being investigated here. A part closely associated with the wheel is the hub upon which it is mounted. In one cast magesium design the weight is 25 lb, while that of the steel counterpart is 52.5 lb, a saving of over 50 per cent. Experimental sand-cast hubs have been in completely successful use for 2½ yrs on a 25-ton platform truck used in the oil fields, where such trucks frequently are overloaded.

Typifying the usual design changes, in Fig. 7 are illustrated the thicker sections used when cast magnesium replaces cast steel in a brake shoe with a 50 per cent weight saving. Walls and ribs were increased, but it was possible to retain the outside dimension.

In railroad operation, mounting fuel and personnel costs undoubtedly will stimulate increased interest in lighter weight equipment to secure the maximum payload out of the total tonnage hauled. As perhaps the largest industrial users of solid and liquid fuels, the railroads might be said to have a public responsibility to conserve them by operating at the best possible efficiency. While it cannot be said that any parts are in production as yet, preliminary investigations indicate that truck side frames and bolsters are definite possibilities as magnesium sand castings, with a weight saving of around 50 per cent.

Cast magnesium parts are desirable in such items as are handled by paid labor, where lessened worker fatigue or increased production are worth paying for. This was demonstrated several years ago by the use of cast magnesium hand trucks for handling heavy drums. While somewhat more expensive, due to small-scale production, the trucks were only one half the weight of the fabricated steel trucks. They were, of course, more popular with the workmen, who demanded and received complete replacement of the heavier trucks. Other similar satisfactory applications for magnesium castings are in dollies for handling heavy machinery and in home appliance movers (Fig. 8).

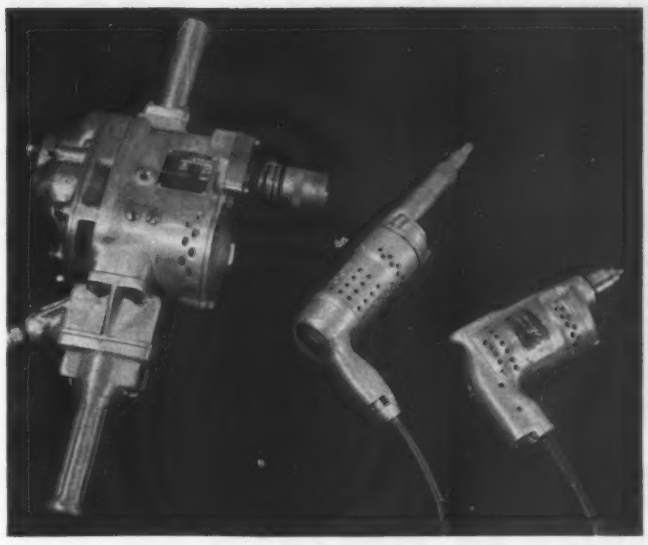


Fig. 11—Portable tools using cast magnesium housings and handles, greatly reducing weight.

Frequently, other factors than the human element will be important. For example, large cable reels made up mainly from magnesium castings are a new development, are lighter than either steel or wood reels and more durable than the latter (Fig. 9). Comparative weights for 60 in. diameter x 32 x 32 in. reels are: wood, 550 lb; steel, 350 lb; magnesium, 238 lb. Wood reels last about five cross-country trips or around two years, while the life of steel or magnesium reels is estimated to be on the order of 50 trips or upwards of 20 years. While initially more expensive, it is anticipated that the savings in freight will make their use attractve and practical.

Of similar nature are the spools or "beams" used in textile mills. These are made with cast end flanges joined by a central barrel of tubing. The smaller flanges are die castings while the larger ones, which may be as much as 30 in. in diameter, are either sand or permanent mold castings (Fig. 10). The use of magnesium for these parts insures the lightest weight for easy handling and freedom from the splintering which frequently occurs with wood and results in snagging of the thread.

Portable Tools

Producers of small and portable tools are making increasing use of magnesium castings. Prewar applications in electric and pneumatic drills and hand tools have revived, of course, while many new ones have been developed (Fig. 11). It has been noted that there is a trend toward the use of permanent mold or die castings

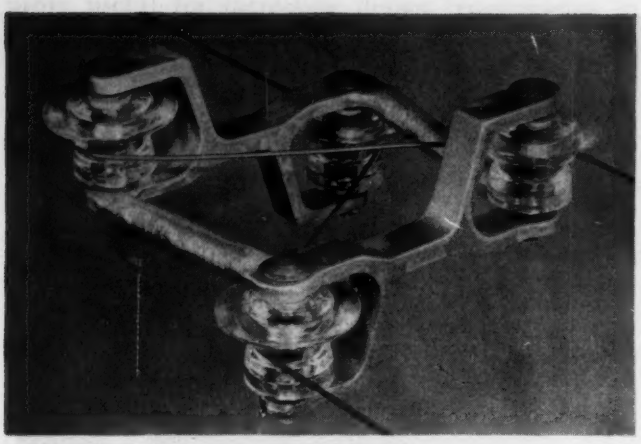


Fig. 12—Cast magnesium transposition bracket produced by permanent mold process.

in portable assemblies, a fact possibly indicative of growing acceptance for magnesium for such use.

Typical additional tools of this class which might be mentioned are levels, safety tongs, brick tongs, mine drills, and chain saws. Almost any tool or portable piece of equipment which must be manually carried or used can benefit from the incorporation of magnesium castings in the design. Compared to iron or steel parts, a saving in weight of from one half to three quarters is possible, while as much as one third frequently can be attained in replacing aluminum.

Production Equipment

It has been found advantageous also to use magnesium castings in production equipment which must be handled many times each day, resulting in lessened worker fatigue. An example of this is foundry snap or slip flasks for which magnesium castings have been used successfully for many years. Large flasks, assembled from sand-cast panels, also have proved out well. In some cases the weight saving has been so great, running into the hundreds of pounds when iron was replaced, that larger molds could be made on the molding machines, thus, in effect, increasing their capacity and nullifying any additional cost.

Other foundry uses for magnesium castings are permanent mold cast bottom boards and core plates, both of which have stood the test of service. A proposed application somewhat similar to the last is a die or permanent mold cast cement block pallet. It should be noted that the alkalinity of the cement has no effect on magnesium. An interesting use is for die cast magnesium baker's peels, the flat paddles used for insertion and removal of pans from production ovens. The magnesium is light in weight, about 2.5 lb, but its unique characteristics here are freedom from checking and charring, which limit the life of a wood peel to about two weeks compared to a year for the metal peel, and just the right friction or "stickiness" in contact with the baking pans.

Quite often the use of magnesium for reciprocating or moving parts of production machinery will result in lessened vibration and thus permit higher speeds and output. Textile looms, packaging machines, and printing presses are but three examples. As an indication of the possibilities in this direction, it may be pointed out that in Germany in 1938, about 300,000 lb of magnesium per month went into textile applications, considerably more than was used in the United States at the time in all applications in all industries. This was not due to the scarcity of other metals in Germany, as some have supposed, but rather to an early recognition of the production advantages accruing through the use of the lighest structural metal.

Electrical Equipment

In the electrical industry many opportunities exist for saving weight. In the case of a 5-hp electric motor, revised for aircraft use, magnesium sand castings for the main frame, end bells and fan reduced the weight of these parts from 21 lb in cast iron to 5.1 lb, a reduction of 75 per cent.

Permanent mold transposition brackets recently have been introduced to eliminate interference between communications carrier circuits (Fig. 12). The light weight permits them to be hung directly on the wires at the optimum intervals. Magnesium die castings were used extensively in radar, radio and other electrical instruments during the recent war, and it seems logical that applications will be found for them in the electrical control and communications fields.

The use of magnesium castings in consumer goods is only just beginning to develop significantly. Necessarily prohibited during the war, magnesium has been considered for many such applications during the past two years, in a period clouded by postwar material and product scarcities. Many of the proposed uses require a trial period, not so much for the materials, but for the basic article itself.

Of the countless new designs being brought out, those combining the most suitable materials, sound engineering and manufacturing, and good merchandising will survive. The following example may be considered as typical of the several consumer fields in which magnesium castings are being used with every prospect of permanent success.

One of the most promising of the new applications is in the main metal frames or string plates in piano construction. Formerly of cast iron, these were responsible for the heavy immovability of pianos so much deplored by the American housewife. In one make, the use of magnesium has reduced the weight of the completed piano by 150 lb or about 40 per cent.

Conclusion

In the foregoing discussion it will be evident that the applications using magnesium castings do so because of their light weight. Many existing articles are heavy just because they have always been made of heavy materials. The replacement of heavy castings on present machines or equipment with magnesium helps to improve portability, lessen worker fatigue, speed up operations and decrease maintenance trouble.

Maximum advantages will be realized, however, only when the designer starts from the beginning with a new concept of the possibilities of real weight reduction and builds around the many valuable characteristics of magnesium castings. Using the magnesium alloys and casting techniques which are now available, light weight with its obvious advantages in many fields is obtainable with adequate assurance of strength and durability.

COST COMMITTEE DEVELOPS 1948 CONVENTION PROGRAM

As THE GRADUAL transition from a sellers' market to a buyers' market manifests itself in industry generally, competition in all fields becomes progressively important. Costs therefore, become the common denominator for all competitive selling, so that a knowledge of foundry costs is an absolute necessity to sound competition.

The A.F.A. Cost Committee has long held to the conviction that profitable foundry operation, like the conduct of any successful big business, is contingent upon satisfactory analysis for all plant operations. Consequently, A.F.A., through the cooperative efforts of the Foundry Cost Committee, continues to make available simple cost accounting methods in forms readily adaptable to the smallest foundry. Adoption of the principles involved simply requires individual application, in minor details, to conditions peculiar to a specific plant.

Send Questions Immediately

In order to cover all phases of cost features so that the most general good can be accomplished, the committee intends to develop its 1948 convention sessions from the questions that will be submitted to the National Office between now and February twenty-fifth. Program will revolve about the individual problems presented by all branches of the foundry field and, again, the solution to these problems will be presented simply, following a set pattern that can be applied to similar conditions in other foundries.

However, in order to inject a major theme for the 1948 Foundry Cost Sessions, submitted questions should be restricted to:

(1) Cost problems of general interest, but specific in nature and clearly defined.

(2) Methods of cost accounting, distribution of costs, and application of information derived from cost accounts.

In undertaking this unusual approach to the development of a national convention program, the Cost Committee is prepared to shoulder the added burden that will be incurred through working out recommended procedures which will compromise the answers to questions submitted to the committee comprised of: Ralph L. Lee, *Chairman*, Grede Foundries, Milwaukee; George Tisdale, *Secretary*, Zenith Foundry Co., Milwaukee; C. R. Culling, Carondelet Foundry Co., St. Louis; A. W. Plier, D. J. Murray Mfg. Co., Wausau, Wis.; C. S. Roberts, Dodge Steel Co., Philadelphia; N. J. Schmidt, Gunite Foundries Corp., Rockford, Ill.; and C. E. Westover, Westover Engineers, Milwaukee.

Naturally, the success of such a program largely depends upon the general participation of all branches of the foundry field. A.F.A. members, therefore, are urged to send in questions as early as possible—the sources of all material will be treated confidentially, with original questions and answers to be mimeographed and made available at the Convention Cost Sessions.

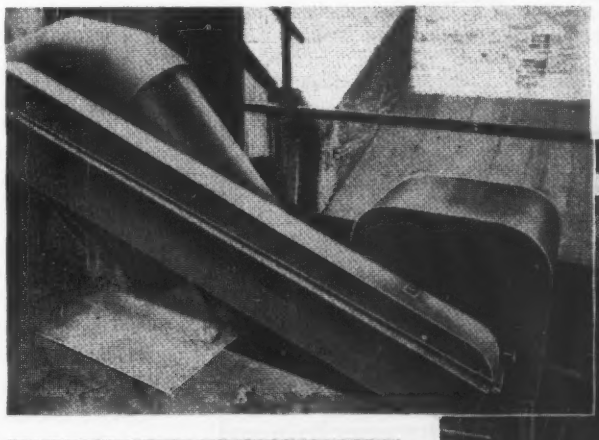
CONVEYOR CUPOLA CHARGING SUCCESSFUL IN ENGLISH PLANTS

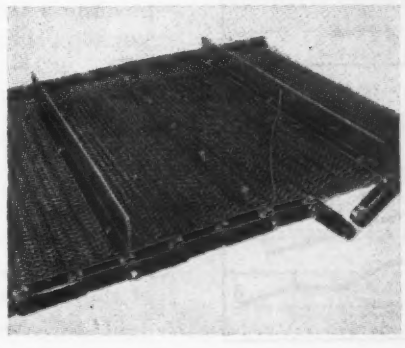
An interesting example of the use of a wire conveyor belt for charging a cupola was shown in a current issue of *Mechanical Handling*. The accompanying illustrations show an English foundry installation.

Prior to this installation it was necessary for men to load a barrow and hoist it up for charging the cupola, or else to carry small quantities up a flight of stairs. This laborious work has now been eliminated through the use of the conveyor.

Material to be charged into the cupola is brought to the scales (shown in the photograph, lower right) and material is fed on to the totally enclosed wire conveyor belt. The belt is capable of travelling at 6 ft. per min. The drive is supplied by a 3-phase AC enclosed type electric motor through a reduction gear box and 2:1 step-down ratio giving a final output speed of 1 rpm. Headshaft drive is by 1-in. pitch chain. The belt is fitted with positive chain drive and transverse baffles 3-in. deep.

This application of conveyor feed to a cupola has resulted in one man operated charging with complete safety to the employee.





ANNEALING OVENS

Equipment and Practice for Malleable Iron

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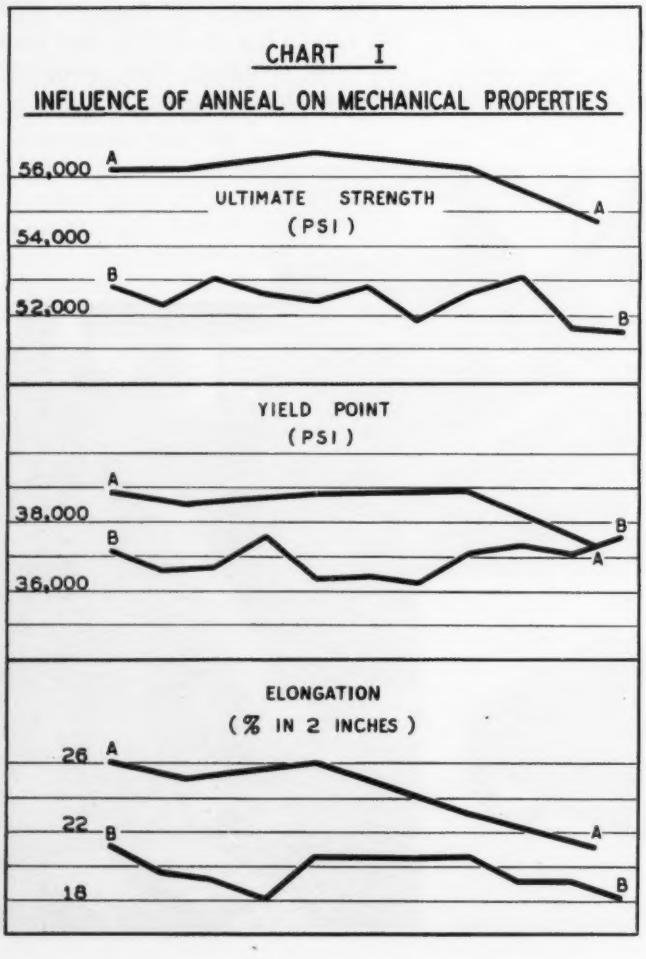
IN THE EARLY DAYS of the malleable industry, periodic pot type and periodic muffle ovens were about the only annealing equipment in use. Today, so many types are available that a review of their characteristics may be timely. They will be considered under the general headings of periodic and continuous types.

I. Types and Use of Periodic Ovens

A. Periodic Pot Type—In the use of periodic type ovens it is important to have thermocouples in the pots or to know the oven and pot temperature differentials that exist during the annealing cycle. In heating, the oven temperature will far exceed that of the castings in the pots; when at temperature the oven and casting temperatures will be relatively close together, depending on time at temperature. In cooling the castings still may be well above the critical range, when the oven temperature is well below it.



Pulverized-coal or oil firing, as compared with hand-firing, increases furnace capacity and efficiency by eliminating the firebox and numerous flues. In most cases fuel economy is also effected, as less coal is required with pulverized than with hand-fired practice. However, there are some installations where improved hand-fired practice, which includes the application of forced draft, reduces coal consumption to an extent where it compares favorably with pulverized-coal practice.

The adoption of bottom pots or separator plates in periodic type ovens results in a saving of time and labor by the elimination of packing material. In some cases the type of casting involved makes this impracticable unless they are to be straightened after annealing. The use of packing presents a dust problem, which may be solved by placing the stack on an enclosed shakeout grating with the stack bottom removed. Obviously, the castings cannot be shaken from the entire stack in one operation if bottom pots or separator plates are used.

Insulating Materials

Economy in both oven construction and operation is now possible through the use of insulating firebrick. These brick have excellent insulating properties and yet possess sufficient strength to be used for both walls and roof of the main oven structure. Many ovens are giving excellent service with 9-in. walls of insulating firebrick, backed up by 1 to 2½ in. of block insulation.

In such ovens the refractory heat storage is greatly reduced, requiring less fuel and time, as well as permitting more rapid manipulation in cooling and holding. Insulating concrete, below the paving brick floor of the oven, and doors of insulating refractory material are of advantage.

The use of such insulating firebrick in ovens makes possible a reduction of cycles to 4 or 5 days.

A typical cycle may be given as:

		Hours
(a)	Heat to 1650F	24
(b)	At 1650F	34
(c)	Cool to 1350F	20
(d)	1350 to 1200F	32
(e)	Cool to handle	10
	Total (5 days)	120

Cars may be used to speed the loading and unloading of these ovens.

B. Periodic Muffle Ovens—The determining factor

in connection with the advisability of muffle oven installation is whether or not sufficient castings which permit stacking are available. Miscellaneous and lightweight castings generally are not adapted to annealing in muffle ovens due to probable warpage and the fact that the decreased density of pack is not conducive to economical production.

Most muffle ovens are oil- or gas-fired; if coal is used difficulty from ash may possibly be encountered. Pot cost is eliminated, a greater tonnage can be annealed in a given space and fuel consumption is reduced. A small amount of lump coal generally is placed within the muffle to prevent scale formation.

The only disadvantage of these ovens is that the castings are in the oven for a greater length of time than are castings in the pot ovens. This increase in time is caused by loading and unloading and the fact that cooling cannot be accelerated.

A typical cycle is:

	Hours
(a) Heat to 1700F	36
(b) At 1700F	30
(c) Slow cool 1700-1200F	72
(d) Cool to handle	36
Total (7¼ days)	174

C. Periodic Car Type Muffle Oven—Some use is being made of car type muffle ovens which greatly reduces the "in oven" time of the load. The cars may be loaded rapidly and, after the annealing cycle is complete, withdrawn for rapid cooling and unloading. They seem to possess all the advantages of the standard muffle and none of its time disadvantages.

Oven Refractories

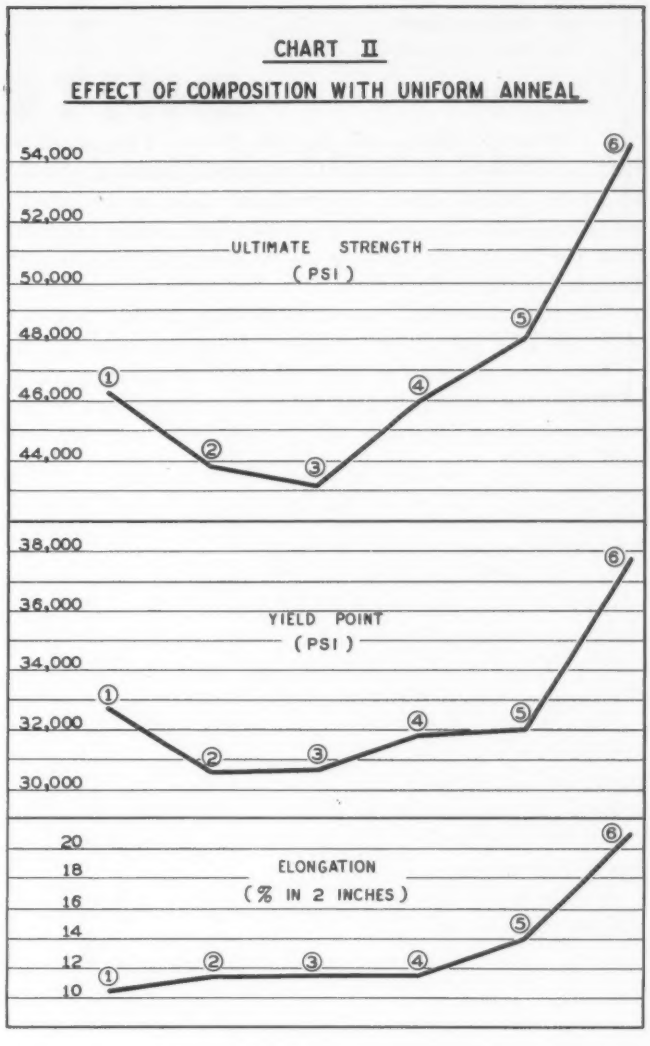
More rapid heat transfer is accomplished in the construction of the muffle arches by the use of carborundum refractories. Castings which may be compactly stacked without warping are, of course, necessary for efficient use of this equipment. In some cases straightening will be necessary.

A typical cycle is:

	Hours
(a) Heat to 1750F	24
(b) At 1750F	20
(c) 1750 to 1360F	18
(d) 1360 to 1300F	24
(e) Cool to handle	10
Total (4 days)	96

D. Periodic Car or Tray Type Radiant Tube Oven—Gas-fired radiant tube heated ovens are found to be particularly economical and satisfactory in localities where gas rates are especially attractive and a fairly heavy tonnage of castings which permit close packing on a car or large tray is being produced. This is especially true when the castings in question are to be die-straightened prior to shipment, in which case possible slight warpage becomes of no importance.

Inasmuch as no pots are used a controlled, non-oxidizing atmosphere protects the castings in the oven from oxidation. Manifest advantages include elimination of pots, possibility of rapid temperature changes which result in economical heating, and a considerably shortened annealing time. As the mass of the batch has some lag effect in temperature changes, the time required is not quite reduced to that possible with a similar but continuous or conveyor type of equipment.



Fuel cost, with favorable natural gas rates, is at a minimum, pot cost is eliminated, and alloy cost per ton is less than half of the average pot cost.

A typical cycle is:

	Hours
(a) Heat to 1750F	7
(b) At 1750F	28
(c) 1740 to 1400F	3
(d) 1400 to 1100F	44
(e) Cool to handle	2
Total (3½ days)	84

E. Periodic Car Electrically Heated Oven—This type of oven, generally of the elevator car type which may be used in conjunction with one, two, or three chambers at high and low temperatures, has a relatively high initial installation cost, but is found to be satisfactory and easily controlled equipment, recommending itself especially where electrical rates are low. A further advantage of this type of oven is that, in addition to the fact that pots are not used, it is also possible to anneal the castings without excessive scaling, even though no prepared atmosphere is introduced. The elevator type of oven adapts itself well to temperature change by quenching and to a considerable reduction in the required annealing time.

A typical cycle is:

	Hours
(a) Heat to 1800F	8
(b) At 1800F	8
(c) At 1650F	2

(d) 1650 to 1345F		10
(e) 1345 to 1290F		24
(f) Cool to handle		2
Total	(2¼ days)	54

F. Periodic Shell and Hearth Oven—The application of this type of oven to malleable annealing is of relatively recent date. The radiant tube heated shell, weighing some 25 tons, is crane handled, being lowered over the hearth containing the charge and removed at the end of the cycle.

The hearths usually are 20½ ft long by 6½ ft wide, with the load packed to a height of approximately 5 ft.

This type of oven is well adapted to the annealing of large rear axle housings and, in general, to the annealing of large castings which may be closely packed and stacked to a considerable height without other support. Some use is made of these ovens in annealing smaller castings, but in this case full economy cannot be realized as pots must be used.

If a 25- or 30-ton crane must be installed, these ovens would seem to recommend themselves where the production is normally sufficient to require at least three shells. This would distribute, and thus materially reduce, the crane investment cost per oven.

The hearths installed to date have varied in their auxiliary equipment, some being provided with fans to promote circulation, and others with blowers to accelerate temperature reduction when required. The ovens are well sealed and, in general, atmosphere control problems are not involved.

A cycle used with iron of approximately 1.00 percent silicon content is:

		Hours
(a) Heat to 1650F		24
(b) At 1650F		42
(c) 1650 to 1300F		1
(d) 1300 to 1280F		29
Total	(4 days)	96

II. Types of Continuous Ovens and Their Use

A. Continuous Pot Type—These ovens have mechanical advantages in bringing the castings rapidly into high-temperature zones, accelerating the cooling to the critical, holding at that point and just under, and making the pots readily available for dumping as soon as the anneal is completed. Most of the installations are large, and consideration must be given to possible reduction of operations to a point where sufficient tonnage is not available to keep the oven in continuous operation, without which it is not efficient. Experience indicates that the longer type of oven is the more satisfactory.

A typical cycle is:

		Hours
(a) Heat to 1760F		24
(b) At 1760F		30
(c) 1760 to 1400F		15
(d) 1400 to 1200F		30
(e) Cool to handle		3
Total	(4½ days)	102

B. Radiant Tube Heated Continuous Ovens—These ovens possess the advantages of the smaller batch type ovens mentioned previously and, in addition, the small quantities that are continually entering the various zones are not subject to the lag caused by the requirement of heat change in any considerable mass of material at one time. The time requirements may therefore be reduced to a minimum.

Again, these ovens recommend themselves as being economical when low gas rates are available and a large tonnage of relatively uniform castings is being produced. Here, also, if the castings are to be die straightened following anneal, possible warpage due to lack of pot, or packing support, is not a factor. Installation cost is a considerable item, and as in the case of the continuous pot type oven, one must be assured of a sufficient tonnage of suitable castings to keep this oven in continuous operation if maximum efficiency is to be obtained.

A typical cycle is:

		Hours
(a) Heat to 1500F		4
(b) Heat to 1750F		6
(c) At 1750F		14
(d) 1750 to 1400F		2
(e) 1400 to 1300F		20
(f) Cool to handle		1
Total	(2 days)	47

C. Continuous Electrically Heated Oven—What has been previously mentioned with regard to a radiant tube continuous oven applies in general to the electrically heated oven, the electric heat, of course, being indicated in localities where electric rates are more attractive than gas rates. The satisfactory control obtained with electric heat is generally known. On continuous electrically heated ovens, it is customary to use a controlled atmosphere, utilizing some gas, as in the case of the radiant tube ovens. The cycle also would conform to that of the radiant tube continuous oven.

The cycles listed in connection with the various types of ovens are not, of course, the only ones which are practicable. The use of higher-silicon content metal will reduce the required hours in many cases. Other conditions, in various plants, may operate to increase substantially the required annealing period.

Illustrative of the effect of varying annealing practice are plotted values obtained from specimens from the same heats but treated under varying annealing conditions, and shown in Chart 1. It will be noted that anneal "A" gives values which are higher by some 3500 psi in ultimate strength, 1500 psi in yield point, and 5 per cent in elongation.

Metal Composition

While stressing the anneal, sight of the importance of the metal to be subjected to the heat treatment should not be lost. To indicate this importance as well, Chart 2, in which specimen "6" has been annealed in the same pot with specimens 1, 2, 3, 4 and 5, these being of a substantially different type of metal, was prepared. It is of interest to note that none of the first five specimens attained even 50,000 psi in ultimate strength, whereas specimen "6" tested in excess of 54,000 psi. Also, in yield point only one of the first five specimens reached 32,500 psi, whereas specimen "6" registered in excess of 37,000 psi. In the case of elongation the improvement was similarly striking.

It is believed that the comparisons demonstrate the importance of both annealing and original metal control in maintaining quality standards.

CENTRIFUGAL CASTING

Process Applied to Stainless - and Carbon - Steel Tubes

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and
J. W. MacKay
American Cast Iron Pipe Co.
Birmingham, Ala.

CENTRIFUGAL CASTING OF METAL has been a routine production technique in this country for more than 25 years. Prior to 1942 this method was confined largely to the manufacture of cast-iron pressure pipe in sand-lined molds and in metal molds. The process has amply demonstrated its economic soundness and has resulted in a product vastly improved over the antedated pit-cast pipe.

The advent of war created demands for much material which could not be satisfied through the usual supply channels. These exigencies accelerated research toward the end that suitable facilities might be utilized to overcome these deficiencies. A critical shortage existed in that period for forgings and for rolled steel tubes of almost every description. It was a natural progression to attempt production of centrifugally cast steel tubes in pipe-making equipment. This paper is concerned with problems encountered and results achieved in the production of relatively heavy-wall, centrifugally cast, steel tubes.

By this we mean tubes having wall thicknesses approximately equal to A.S.A. Schedule 80 thickness for outside diameters from 3.5 in. through 16 in.; not less than Schedule 60 for 18 in. through 24 in., with 1-in. to 1⅛-in. wall being the minimum for tubes 25 in. through 50 in. OD. These designations are synonymous with the former "extra-strong" pipe thicknesses through 10-in. pipe size. Generally, this means ⅜-in. minimum wall up to and including 7-in. OD tubes; ½-in. wall through 10.75-in. OD tubes; ⅝-in. wall through 14 in. OD, ¾-in. wall through 22 in. OD, ⅞-in wall through 26 in. OD, and 1- to 1⅛-in. wall for diameters to 50 in.

Tube Size Ranges

It is possible to produce centrifugally cast steel tubes with ¼-in. walls through 24 in. OD, but these tubes are usually high-alloy steel and are furnished in short lengths of 4 ft to 9 ft. The experiences described herein are in connection with the manufacture of tubes having ⅜-in. to 5-in. walls in a range of sizes from 3.50 in. to 50 in. OD, and cast in sand-lined molds in nominal 16-ft lengths. Steel is melted in acid-lined electric-arc furnaces.

No basic changes in pipe-making machinery were required to produce centrifugally cast steel tubes. This was most fortunate, as the extensive pipe-making equipment available could be used to produce centrifugally cast steel tubes in an extensive range of diameters. A high-heat-resistant sand was necessary, and one composed of the following parts by volume has given excellent results: 16 parts clean silica sand; 2 parts bentonite; 2 parts silica flour; 2 parts fireclay.

This sand is mixed in a 2-yd muller. Permeability averages 115, green compression strength about 12 psi, and moisture approximately 6½ per cent. Molds are faced with a core wash made up in a volume ratio of 1 part silica flour, 1.2 parts steel-wash paste, and 2 parts water. This mixture has a specific gravity of about 1.40.

Orifice pouring devices are required for best results. On tubes up to 12 in. OD, orifices are 1½-in. to 1¾-in. diameter, depending on the analysis, pouring temperature and volume of metal to be poured. Similarly, 1½-in. to 2-in. and sometimes 3-in-diameter orifices are used on larger-diameter tubes 13 in. through 50 in. OD

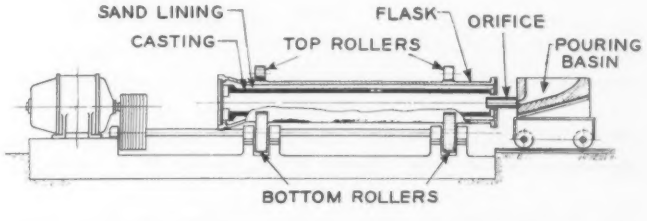


Fig. 1—True centrifugal machine for long-tube casting.

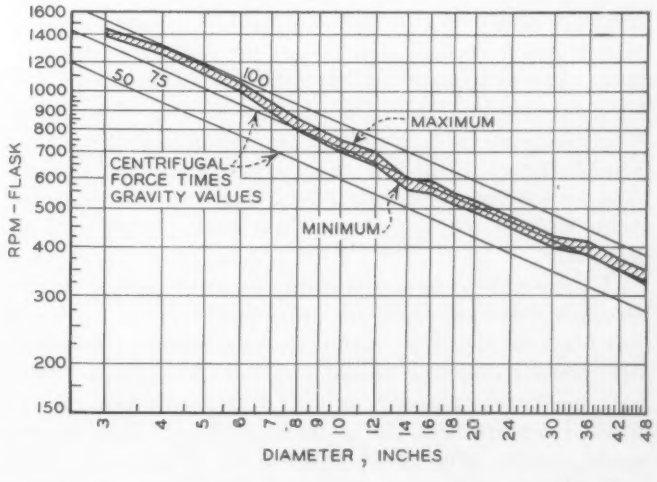


Fig. 2—Typical diagram showing tube casting speeds.

This paper was presented at the Semi-Annual meeting of ASME in Chicago, June 16-19, 1947, and published in *Mechanical Engineering*, July 1947.

STEEL TUBE CASTING DATA

Date Cast 2-21-47 Heat No. 46813 Customer S.O. 4166

Cast OD 14.40" Cast ID 11.00" Cast Length 16'-0" Weight 3640 Type Steel 4150

MOLD

Pattern O.D. 14.77 Special Size Staves None Flask I.D. 22½"

Sand Sampling Bell, Middle & Spigot while ramming

Sand Mix - Kind and %		Binders - Kind and %	
Steel Sand	35.7	Fireclay	10.8
Ga. Wash	35.7	Bentonite	8.9
Silica Flour	8.9		

Time Rammed 11:00 2-18-47 Ramming Time 10 Min No. Rammers 2

Mold Hardness-Green Spigot 80-90 Dry Faced Immediately

Mold Facing - Kind Steel Wash - 1.5 sp. gr. Application Poured on Amount 10 Gal

Time Air Dried 26 Hr Time Under Heat 24 Hr

Drying Remarks 22 Hr slow heat; 2 Hr high heat before casting

Faced and Dried Mold Hardness Bell 84 - Spgt. 88 Rotator Speed 18 RPM

Mold Temperature Bell 130°F Appearance of Mold Good

Remarks

CASTING

Time Tapped 9:22 AM Tap Temp. 3220°F Ladle Temp. Hot

Time Weighed 9:40 (3010°F) Ladle Temp. Medium Hot

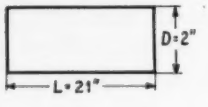
Time Pouring Ladle 9:42 (2850°F) Ladle Temp. Medium Hot

Time Cast 9:45 Pour. Temp. 2900°F Pouring Time 2 Min

Additions 6 lb liquidizer to ladle; 20 lb riser-x to each end of tube immediately after pouring.

Max. Height in Trough 10" Time to Reach End of Mold 50 Sec

Orifice Flask Speed RPM 600 For 1 Min Cut Back to 587 In 1 Min



Held at 587 For 1 Min Cut back to 571 in ½ Min Held at 571 For 10 Min Cut back to 504 In 2 Min Held at 504 for 10 Min Cut to 428 rpm-20 min-Held

Total Spinning Time 1 Hr

Remarks Flask running was smooth. Slag formed by riser-x dripped profusely at shutdown.

STRIPPING

Time Stripped 2-22-47 Temp. Bell Cold Middle Spigot

Appearance of Casting Good - Magnetic particle inspection OK

Fig. 3—Example of form used to record casting data.

with the same factors governing choice of orifice size.

Cylindrical cast-iron flasks approximately 16½ ft long are stood on end and centered on a rotating head which has a conical depression for receiving the pattern. At the opposite end the flask is likewise centered by guide rollers. A metal pattern is lowered into the flask and carefully centered at each end. Refractory sand is then fed into the annular space and thoroughly compacted around the pattern by pneumatic rammers. Sand linings are 1½ in. to 3 in. thick, depending on flask size.

Thoroughness in compacting the sand cannot be too strongly emphasized as this minimizes tendency toward hot tears on the tube surfaces. A common mold-hardness testing machine would give values of about 90-92 for the usual rammed mold. After ramming of the mold is completed, the pattern is drawn leaving the mold cavity. The mold is air-dried, then faced with silica-flour wash, after which it is dried by a gas flame.

Special care is taken to insure that the molds are well dried. Damp molds would result in heavy pitting of the tube surface and scouring of the mold during pouring. In the absence of better checking methods, we have assumed that a mold is completely dried when the temperature on the outside of the flask reaches 250 F.

When suitable stop-off plates, faced with hard-baked oil sand rings, are keyed into the flask ends, the flask-mold combination is ready for the horizontal casting machine. All flasks are dynamically balanced in a special flask-balancing machine. This is a most important requirement considering the speeds at which the flasks are revolved. Failure to do this may result in the flasks "whipping," with possible damage to the casting machine, and almost certain cracking of the tube during the initial freezing phases where hot strength is low.

Figure 1 shows a typical machine with indirect drive, the flask resting on four rollers. Casting is "true centrifugal." The mold is spun about its own axis and utilizes centrifugal force imparted by the revolving flask to hold molten metal against the wall of the mold until the metal solidifies. The interior cavity is a true cylinder. This type of machine is well adapted to the rapid and economic manufacture of tubes in long lengths. The inside diameter and the wall thickness are determined by the volume of metal poured. Pouring temperatures range from 2750 F to 2950 F.

Casting Speeds

Using the experience gained in manufacture of cast-iron pipe, a "favorable" mold speed at pouring has been determined as one that will give a force of about 75 times gravity, that is, 75 lb pressure per pound of metal. By favorable we mean a speed that will provide sufficient force to place and hold the molten metal on the mold wall and at the same time squeeze out the impurities of lower specific gravity, such as dirt, slag, sand, and gas pockets.

In thick-walled castings it is necessary to select a compromise diameter for the 75 g to avoid excessive force at the outside diameter.

A convenient formula to use in calculating centrifugal force in terms of "times gravity" is

$$g = \frac{N^2 \times \text{diam}}{70{,}500}$$

where g = number of times gravity
N = rpm
D = diameter, in.

Number of times gravity, g, can be calculated for both the outside diameter and the inside diameter, and a compromise speed selected so that g is at least 60 at the ID and, if possible, not over 100 at the OD.

Figure 2 shows a typical diagram for speeds required to produce 50, 75 or 100 g in a large range of diameters. The shaded area indicates speeds which are used in most instances.

Spinning speeds are critical in determining to a large extent the soundness of tube castings. If the speed is too slow, the metal will not "pick up" on the mold wall, with resultant slipping or "raining" until the metal solidifies. This condition will cause laps and entrapment of foreign inclusions. At the other extreme, excessive spinning speed may produce high "hoop" stress, or circumferential tension, causing longitudinal hot

tears. That these factors are not left to chance is well demonstrated by the very complete casting data logged on each tube cast. These records furnish a large reservoir of knowledge and provide a check against performance (Fig. 3).

After cooling, tube castings are mechanically stripped from the mold, subjected to magnetic-particle inspection, then heat-treated. After heat-treatment, tubes are shot-blasted on the outside and dry-ground on the inside, then machined, if required. Heat-treatment consists of annealing or normalizing and tempering.

An essential consideration which always arises in the manufacture of centrifugally cast steel tubes is the amount of stock allowance on the outside and inside diameters, where these surfaces are to be machined. An understanding between buyer and manufacturer on the type of surface required eliminates much confusion that could otherwise occur. For instance, pump casings, which are machined on the outside merely for truing up and are then painted, do not require as perfect a surface as do rotogravure rolls or glue rolls for use on labeling machines.

In the first case, minor pin-point surface imperfections are not objectionable, whereas in the latter instance, such defects render the tube unfit for the intended service. On the other hand, in a hydraulic cylinder, the inside surface is critical, and must be clean for a sliding fit, consequently, sufficient stock must be provided. However, certain types of rolls provide only 1/8-in. stock on the inside, which is bored out for a press fit on a trunnion.

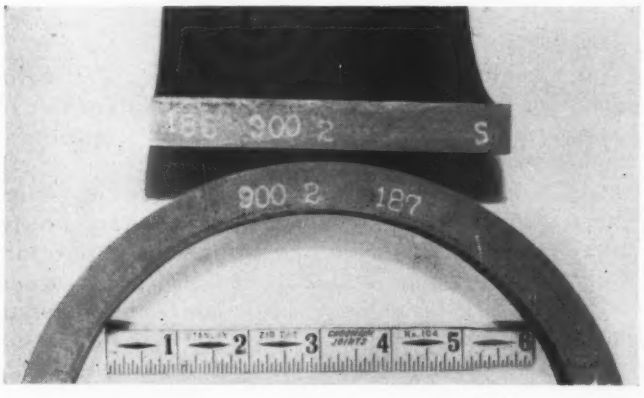


Fig. 4—Cross section of ring cut from centrifugally cast heavy-wall steel tube and deep etched.

Fig. 5—Microstructures of 16-ft-long shaft castings of 0.30 carbon steel. Left—Shaft as cast. Right—Annealed. Etched. × 100.

Fig. 6—Fluted tubes for small electric motor stators.

Our experience dictates the following general practice for providing stock allowance on tubes which are machined on the inside:

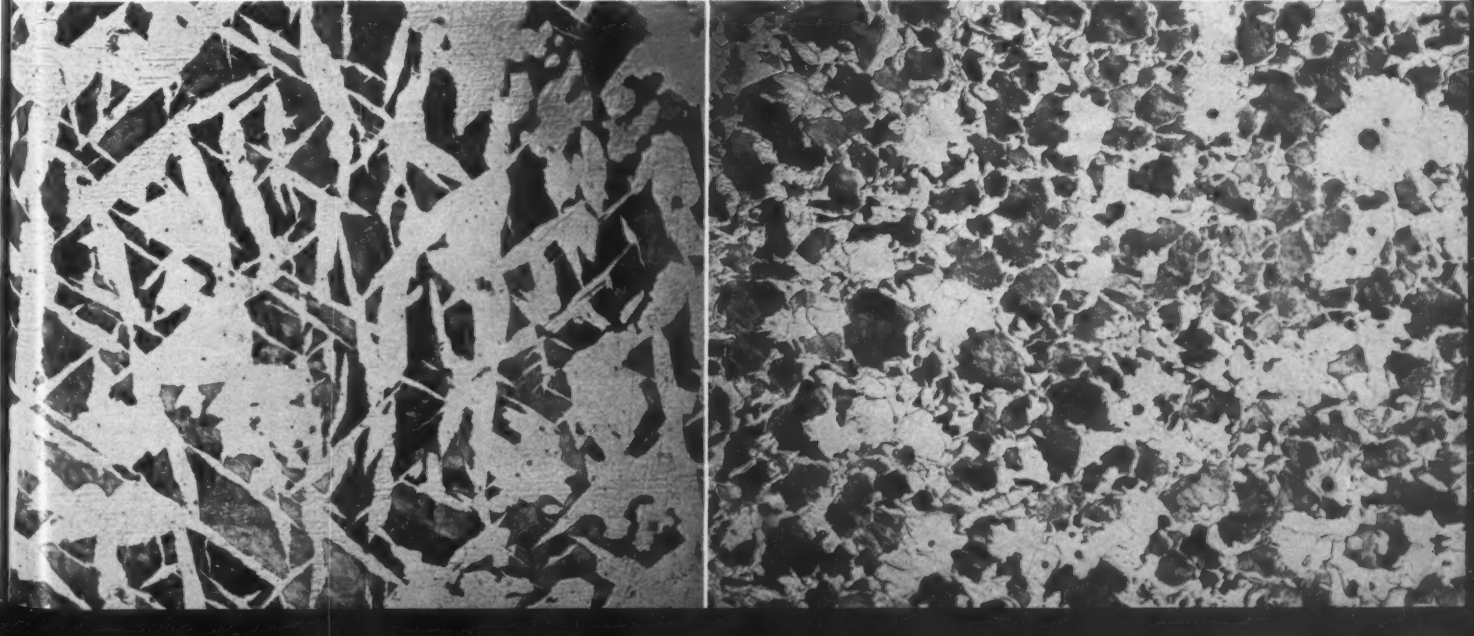
(a) Twenty per cent of the finished wall thickness to the side (1/8-in. minimum) for press fits and general structural purposes.

(b) Thirty per cent of the finished wall thickness to the side (1/4-in. minimum) for sliding and running fits, such as pump and engine cylinder liners where pin-point imperfections are not permissible.

It is probable that as methods and practices are improved, the stock allowances may be reduced materially.

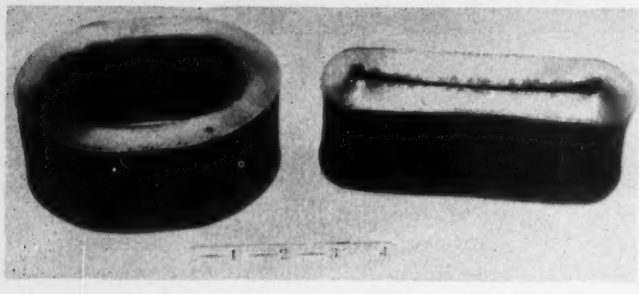
Due to the inherent nature of centrifugal casting, the metal just below the outside sand-cast surface is the most dense and, correspondingly, the cleanest metal in the tube. This is proved in practice. Tubes of extremely heavy walls, such as 5 in. thick, clean up in machining on the outside diameter with a maximum of 1/4-in. stock removal. The average is 1/8- to 3/16-in. allowance for machining purposes.

Figure 4 shows a ring cut from a heavy-wall tube and deep-etched. The line of demarcation between the solid metal and the slag-admixture metal is clearly seen on



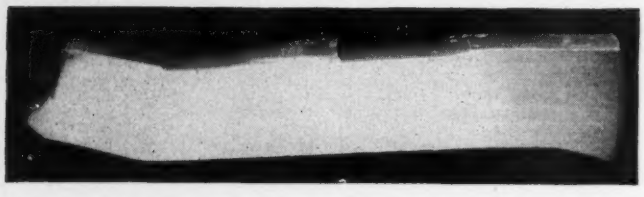
Flared 19 per cent, ASTM requirement

Flared to limit of testing machine



Flattened to 4X wall thickness, ASTM requirement

Completely flattened without failure



Cross section of tube end which was rolled into still header box using a standard tool and a roll expansion of $^{13}/_{64}$ in. Note the sharp shear lines and flare.
(Tests made in accordance with ASTM Specification A200 for seamless tubing.)

Fig. 7—Tests on alloy centrifugally cast steel tubes.

the inside of the tube. Note that the band of surface metal on the outside is considerably narrower.

Although it is commonly accepted that centrifugally cast tubes have true directional solidification, cooling from the outside inward, this may not be the case in thick-wall tubes, especially in the larger diameters. An analogism here shows that there is simultaneous freezing action from the inside diameter outward.

Fortunately, the refractory sand mold, being a better conductor, dissipates heat much more rapidly from the outside of the tube while the inside is insulated by a warm air blanket. Because cooling proceeds much faster from the outside, slag and foreign inclusions are driven to the inside surface where, for the most part, they are ground out in the cleaning operation. In very thick wall tubes the boundary line between the slag strata and solid metal may extend somewhat further outward from the inside diameter.

Exothermic materials, or liquidizers, introduced on the metal in the ladle and placed on the interior surface of the tube immediately after casting, are of some advantage in keeping the metal liquid at the inside-diameter to allow dross to work toward the tube inside and as an aid in the reduction of full line subsurface shrinkage.

In small-diameter alloy still tubes with approximately $^3/_8$-in. wall, the freezing action is so rapid that a very thorough grinding results in almost 100 per cent yield of serviceable material.

Cast-Tube Structures and Properties

The structures found in centrifugally cast steel tubes are not essentially different from those in any sound well-fed steel casting. A typical example is shown in Fig. 5, where we have the as-cast and annealed structures of thick-walled centrifugally cast 16-ft steel tubes.

Grain size of carbon- and low-alloy-steel tubes can be controlled to size 5 or finer where desirable. Grain size of high-alloy heat- and corrosion-resistant steel tubes may be varied within limits, depending primarily on wall thickness and pouring temperature.

Test specimens machined from the walls of centrifugally cast tubes give physical properties comparable to those obtained from separately cast keel-block test coupons, taking into consideration the known effects of section size. Of special significance are numerous tests indicative of the equal strength or load-carrying ability of centrifugally cast tubing in both the transverse and the longitudinal directions. This is in contrast to the directional properties inherent in rolled tubing. This factor is predominant in designing for high-temperature service where creep properties are a primary consideration, and also in cases where internal pressure is a design factor.

At the present speeds used in centrifugal casting of thick-wall steel tubes there is a minimum amount of segregation. Whether or not this would be greater at higher speeds cannot be said, based upon our experience. Pouring temperatures probably would have greater effect. In very hot metal cooled very slowly, there would be the maximum amount of segregation. Chemical analyses on sections from 0.30 per cent carbon 2-in. wall tubes show little difference from outside to inside. On these particular tubes, the carbon and sulphur contents ran a few points higher at the inside surface. The average variation in carbon was about 0.035 per cent and in sulphur about 0.004 per cent.

The field for centrifugally cast steel tubes is both large and varied. Applications proved in war are now generally accepted usages. It should be brought out that centrifugally cast steel tubing in the smaller diameters and in the usual carbon-steel grades is not competitive with the normal thicknesses of rolled and welded tubes. However, considerable economy will accrue where tubes in the high-alloy grades may be required, or for very heavy wall tubing, where physical properties are the major consideration.

Fields of Application

In addition, centrifugally cast tubes can be produced in special outside shapes, such as, square, elliptical, hexagonal, or with flutes, by the simple expedient of constructing suitable patterns. Where sufficient quantities are required, these shapes may prove very economical. Figure 6 shows this type of casting. These tube castings serve to illustrate the accuracy which can be maintained on specification work. Tubes are as-cast $4^3/_4$ in. OD $\times$ $4^1/_{16}$ in. ID. Casting tolerance on the outside diameter was plus or minus $^1/_{64}$ in. Tubes can be furnished with plain ends, threaded ends, or with screwed or welded flanges of the slip-on type.

TABLE 1—CASTING DATA—CENTRIFUGALLY CAST STEEL TUBING

Application	Type steel	Outside diameter, in.	Thickness, in.	Length, ft-in.	Weight, lb.
Magnesium retorts	28% Cr-20% Ni	12.25	1.12	16-0	2106
Furnace rolls	29% Cr-15½% Ni	3.00	0.38	16-0	176
Still tubes	5% Cr-0.50% Mo	4.00	0.44	16-0	265
Still tubes	25% Cr-20% Ni	6.72	0.45	16-0	477
Steam superheater	27½% Cr-15½% Ni	3.92	0.43	16-0	253
Safety sleeves	9% Cr-1¼% Mo	6.12	1.00	16-0	865
Penicillin manufacture	18% Cr-10½% Ni	6.55	1.06	16-0	983
Shaft	5% Cr-0.50% Mo	8.50	2.25	16-0	2375
Radiant furnace	27% Cr-13% Ni	5.66	0.36	16-0	322
Pump cylinder	18% Cr-8% Ni-Cb	4.58	0.92	16-0	569
Pump liners	13% Cr-0.80% Ni	11.25	1.56	16-0	2553
Pump liners	17% Cr-12% Ni-3% Mo	5.80	1.15	16-0	903
Chemical retorts	AISI 310	34.80	1.62	12-0	6808
Paper roll	28½ Cr-9% Ni	19.60	1.49	11-6	3276
Forge-press bushing	SAE 4820	14.38	2.38	16-0	4824
Aviation gas turbine	25% Cr-20% Ni	21.70	0.73	8-6	1365
Aviation gas turbine	25% Cr-20% Ni	13.56	0.78	16-1½	1700
Shaft	SAE-6325	8.52	2.25	16-0	2400
Shaft	SAE-4140	7.00	0.92	16-0	945
Shaft	AISI 316	11.22	1.10	16-0	1880
Trunnions	SAE-1020	11.27	3.12	16-0	4295
Trunnions	SAE-1025	14.40	2.70	16-0	5335
Trunnions	SAE-1020	9.69	2.34	16-0	2905
Bearing back	QQ-S-681 Cl.2	14.40	3.95	16-0	6971
Bearing back	SAE-1015	25.00	2.50	12-0	7125
Bearing back	SAE-1015	8.63	0.86	16-0	1129
Gear hub	ABS Gr.1	18.24	4.00	12-0	7215
Shaft	ASTM A27-42-Gr A1	21.38	5.00	9-6	8212
Rolls	SAE-1030	17.60	3.12	16-0	7630
Stern tube	ABS Hull	33.00	4.00	8-5	10300
Screw conveyor	SAE-1025	18.30	3.80	12-0	6979
Machine part	SAE-1045	22.62	3.31	10-6	7100
Bushing	SAE-4150	25.00	3.25	11-0	8200
Machine parts	SAE-1025	26.00	2.50	12-4	7650
Machine parts	SAE-1025	20.70	2.50	12-0	5763
Rolls	SAE-1015	30.00	1.37	16-0	6647
Tug shafts	49-S1-B	8.52	2.50	16-0	2530
Destroyer escort shafts	49-S1-B Mod.	9.17	2.00	16-0	2420
Rolls	SAE-3115	5.50	1.75	16-0	1108

Use of centrifugally cast stainless-steel tubes during the past few years in such installations as refinery stills and chemical retorts has demonstrated their ability to perform satisfactorily and economically.

Tests demonstrating the workability of centrifugally cast steel tubing have dispelled much of the misconception that such castings are "too stiff" for use in some industries. Figure 7 shows representative tests on 4.75-in-OD × 0.80-in-wall × 16-ft-long centrifugally cast alloy still tubes 0.10 per cent carbon, 1.5 per cent chrome, 0.50 per cent molybdenum steel after normalizing and tempering.

The ability to secure long-length centrifugally cast steel tubes in a large range of diameters and to practically any analysis is of utmost economical value to the user or engineer in many instances. For example, a designer requiring three tubes of different diameters and thickness made from an expensive alloy steel may secure as little as a 16-ft length of all of these from the same furnace charge. He would probably experience some difficulty obtaining similar quantities of the desired alloy in the correct sizes from the high-production tube-rolling mills. In the high-alloy steels, these mills usually roll only the most popular alloys, such as, 18-8, 25-12, etc. These must of necessity be confined to the most used diameters and thicknesses, otherwise stocks would accumulate in slow-moving sizes. This is a problem of long standing. The foundry can produce centrifugally cast steel tubes from heats having minimum weights of 2000 lb.

Many ingenious designers have taken advantage of the flexibility and economies of using centrifugally cast steel tubes. Even though many long-length tubes are employed in such uses as hydraulic cylinders, plungers, piston-rod sleeves, hollow shafting, and refinery-still tubes, a considerable quantity of 16-ft cast lengths are cut into short-length cylinders for such services as gear hubs, ring gears, hoist drums, safety-seat rings, bearing backs, pump cylinders, motor and generator frames, and many other uses. These can be made to any desired stainless, alloy or carbon steel with equal facility. There is a broadening field for weldment applications and the present-day designers would do well to enlighten themselves on the possibility of utilizing cast-steel tubes in composite structures.

It is evident that there are various applications in industry requiring heavy-wall tubing, and it is in this field that the producer of centrifugally cast steel tubes

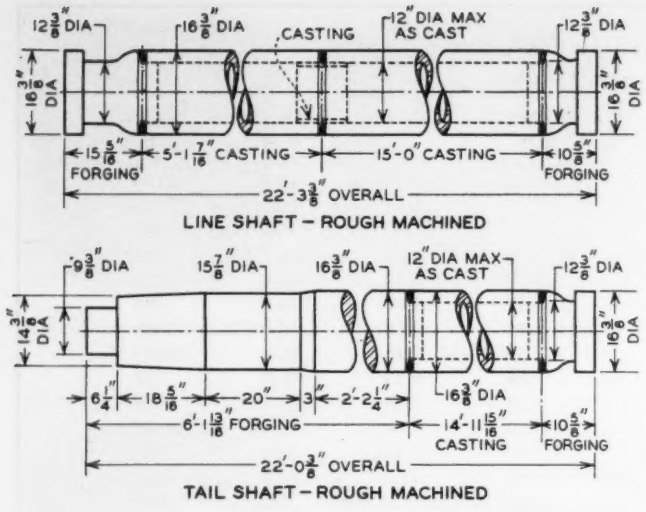


Fig. 8—Sketch showing fabricated and rough-machined line—and tail-shaft sections.

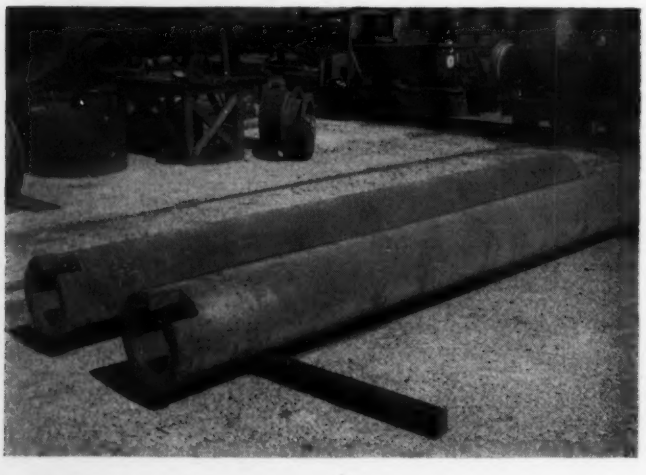
can render a real service. Such applications as shafts, rolls, retorts, and others, where quantities are not large, cannot, as a rule, be serviced by the steel-tube rolling mills. In many cases, heavy-wall tubes have supplanted forgings in shaft applications or machinery parts. A hollow shaft has greater strength than a solid shaft of the same weight.

Some consideration has been given to centrifugally cast steel tubing in the low-carbon-molybdenum grades for use in power piping systems. This is an especially exacting service and requires a material capable of being fabricated into bends, etc. Preliminary tests have indicated the feasibility of cast tubes. The tests are being continued. Table 1 lists in some detail casting data and uses for representative centrifugally cast alloy and carbon-steel tubes.

A clearer understanding of the practicability of centrifugally cast steel tubes can be gained by more detailed information on particular applications. Therefore more pertinent information is contained in the following accounts. Two cases are considered; one a carbon-steel tube application for ship shafts and the other a high-alloy-steel tube for chemical-retort service.

Fig. 10 (right)—Sketch showing weld detail approved by Navy Department, Bureau of Ships.

Fig. 9 (below)—As-cast centrifugally cast carbon-steel ship shafts with plugs removed for test specimens.



Centrifugally Cast Steel Ship Shafting

Relying on the experience of Watertown Arsenal in producing centrifugally cast steel gun barrels for 90-mm guns, the U. S. Navy became interested in the feasibility of making cast-steel hollow ship shafts. Preliminary tests showed promise and centrifugally cast shafting for 20 destroyer-escort vessels was produced. Subsequently, a contract for tug shafting was executed. In turn followed a contract for producing large-diameter shafting for 13 Coast Guard Cutters of the Owasco Class. The vessels are 255 ft in length and require a propeller shaft approximately 44 ft in length, capable of absorbing the torque of a 4000-hp propulsion unit. It is this application which is described herewith.

A propulsion shaft is one of the most critical units of a ship's machinery. The units must render high-fidelity service under severe conditions. Primarily, a shaft is designed to transmit torque from the engines to the propeller. It is recognized that a hollow shaft, with its mass more efficiently placed, is stronger than a solid shaft of the same weight. Shear stress for cylindrical members under torsional loading is determined by the following formula

$$S_s = \frac{QD}{2J} = \frac{16}{\pi}\left(\frac{QD}{D^4 - d^4}\right)$$

where S_s = unit shear stress, psi
Q = torque, in-lb
D = outside diameter of shaft, in.
d = inside diameter of shaft, in.
J = polar moment of inertia, (in.^{4})

In a solid shaft subjected to torsional loading, the shearing stress is zero at the geometrical axis of the shaft and increases in direct proportion to the distance from the geometric axis. Therefore it is a maximum in the fibers at the outer surface of the cylinder.

In a hollow shaft transmitting torsion loads, the in-

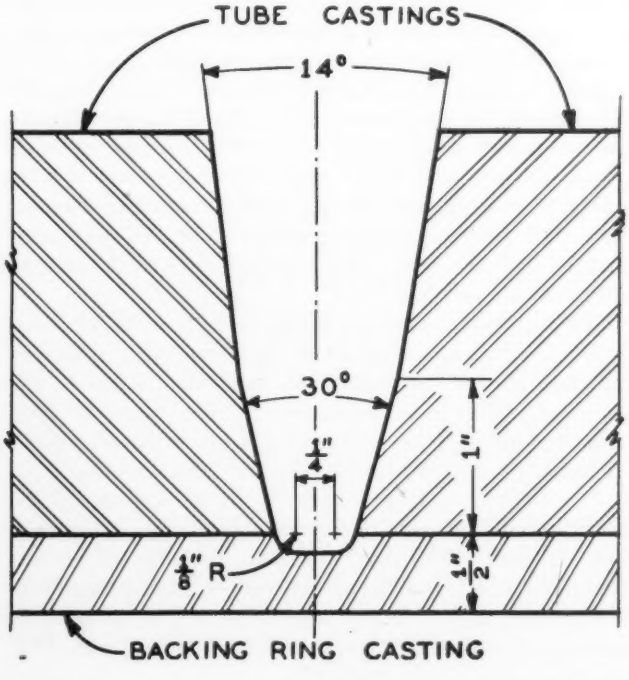


TABLE 2—PROPERTIES OF CENTRIFUGALLY CAST SHAFT TUBE

CHEMICAL COMPOSITION (MAXIMUM, PER CENT)			
C	Mn	P	S
0.35	1.10	0.05	0.05

PHYSICAL PROPERTIES				
Test location	Tensile, psi max	Yield, psi min	Elongation, % min	R.A., % min	1½ in. × ⅝ in. bend
Cut from casting	90000	40000	20	30	120 deg around 1-in-diam pin

side fibers are subject to relatively low unit stress. Where the inside diameter is one half of the outside diameter, the ratio of shear stress at the inside fibers is equal to one half the shear stress at the outer fibers. This fact had been recognized by the Navy but, in view of the expense of removing this metal from a forged shaft, only large shafts for combatant vessels, where weight-saving was important, had been bored. In such cases the inside diameter was bored to 0.6 OD.

Figure 8 shows the fabricated and rough-machined line- and tail-shaft sections. Two centrifugally cast carbon-steel tubes were welded to solid forged coupling to make up the line shaft. One centrifugally cast carbon-steel tube was welded to a solid forged coupling on one end and a solid forged tapered propeller mounting on the other end for the tail shaft. The forgings were 3.25/3.50 per cent nickel steel produced to Bureau of Ships' Specification 49-S-2 (Int.). These units were unique in that it was necessary to develop a procedure for satisfactory welding of the nickel-steel forgings to cast carbon-steel shafting. Prior to this time such work had not been done. On the basis of research work conducted by the Engineering Experiment Station at Annapolis, a special welding technique was developed and has produced excellent results. All weld areas were stress-relieved in specially constructed refractory gas-fired furnaces.

In Figure 9 are shown two centrifugally cast shaft tubes. As-cast dimensions are 16.65 in. OD × 12 in. ID × 16 ft long. Cast weight is approximately 7100 lb each. Note that, from one end of each tube, test coupons have been taken. These tubes were produced to Bureau of Ships, ad interim, Specs., 49-S-1 dated 7-1-42 (chemical and physical exceptions shown in Table 2).

TABLE 3—SHAFT WELDING DATA

MANUAL WELDING	
Current	Alternating except first pass
Preheat	450-500 F
First pass	5/32 in. A.W.S.E.-6010 rod 205 amp at 30 v, reverse-polarity direct current
Remaining passes:	
3/16-in A.W.S.E.-9020 rod	215 a at 30 v, alternating current
¼-in. A.W.S.E.-9020 rod	245 a at 35 v, alternating current
Time	16 hr
AUTOMATIC WELDING	
Current	Direct
¼-in. A.W.S.E.-9030 rod	325 amp at 28/30 v, straight polarity
Preheat	450-500 F
Time	8 hr

Fig. 11—Photograph showing automatic welding of centrifugally cast carbon-steel ship shafts.

Average test results on 0.505 tensile bars cut from the tubes gave the following: Tensile strength, 75,000 psi; yield point, 44,000 psi; elongation, 27 per cent; reduction of area, 45 per cent. Steel was produced in acid-lined electric-arc furnaces and casting procedures were as previously described.

After casting, tubes were cooled in the mold for 24 hr, then stripped, cleaned, inspected and annealed in a batch-type oven at 1650 F for 2½ hr, and furnace-cooled to 700 F before removal. Test specimens were cut from tubes after annealing.

Castings were rough-machined to 16⅜ in. OD and, after thorough magnetic particle and visual inspection, were machined at the ends for welding. Tube ends were counterbored slightly larger than 12 in. ID × 3 in. deep to give a smooth press fit on forgings and welding sleeve. The weld groove is detailed in Fig. 10.

After assembly and alignment of the machined shaft components, they were tack-welded in position and placed in electrically driven welding-jig rollers. The shaft was revolved to suit the speed of welding.

Welding was both manual and automatic, the latter being shown in Fig. 11.

Data on welding are given in Table 3.

Preheat temperature was maintained during the course of welding by a gas burner directly under the center of the weld. Temperatures were checked with tempil sticks ranging from 450 F to 550 F.

During welding the shaft was constantly rotated in a direction toward the welder and at a speed equal to the rate of progression of the deposition. Electrodes were

Fig. 12—Centrifugally cast finished machined line and tail shafts for Coast Guard cutters.

held at an angle of approximately 3 deg to the vertical, but normal to the longitudinal axis of the shaft. The electrode was oscillated, hesitating at the side walls long enough to wet the surface without undercutting.

The rate of progression in terms of a straight bead was such that 2 in. of electrode produce 1 in. of weld.

After welding was completed, the weld area was stress-relieved in a special refractory gas-fired furnace. Temperature readings were taken from a direct-reading contact pyrometer. The shaft was heated evenly at a rate not exceeding 350 F per hr to 1150-1200 F. This temperature was held 6 hr, then the shaft was cooled at a rate not exceeding 125 F per hr. The shaft was rotated constantly during the stress-relieving operation. Little differential hardness exists between weld metal and parent metal. Excess weld metal was machined off and a final magnetic particle inspection was made. This method of stress-relieving gave straight shafting and obviated the necessity of using large and expensive ovens that would have been necessary to stress-relieve the entire shaft. Figure 12 shows the finished shafts.

As a result of the very evident practicability of centrifugally cast steel tubes for Navy ship shafting, the American Bureau of Shipping approved a specification for this type of shafting in ships under its jurisdiction.

Centrifugally Cast Stainless-Steel Retort

This application demonstrates the versatility of size in the employment of centrifugally cast stainless-steel tubes in the fabrication of a large vessel for chemical service.

In this instance, the designer considered two alternatives in the fabrication of these units: (1) By the use of rolled and welded plates to make up the cylindrical body section with end pieces to be forgings or castings; (2) the use of centrifugally cast alloy-steel tubes for the body section, with statically cast alloy-steel end portions welded to each end.

A decision was made to have entirely cast and fabricated assemblies. The acid electric-furnace steel used was Type AISI 310 modified for these castings to the following analysis: carbon, 0.25 per cent maximum; manganese, 2.00 per cent maximum; phosphorus, 0.04 per cent maximum; sulphur, 0.04 per cent maximum; silicon, 1.75 per cent maximum; chromium, 24/26 per cent; nickel, 19/22 per cent.

Test bars taken from keel-block test specimens showed the following average physical properties: Tensile strength, 74,600 psi; yield point, 35,900 psi; elongation, 40.9 per cent; reduction of area, 45.5 per cent.

Figure 13 is a drawing of the fabricated vessel showing major dimensions.

In this instance no metal pattern was available which would permit casting to the desired outside diameter, including finish allowance for machining. A satisfac-

Fig. 13—Sketch of fabricated stainless-steel retort.

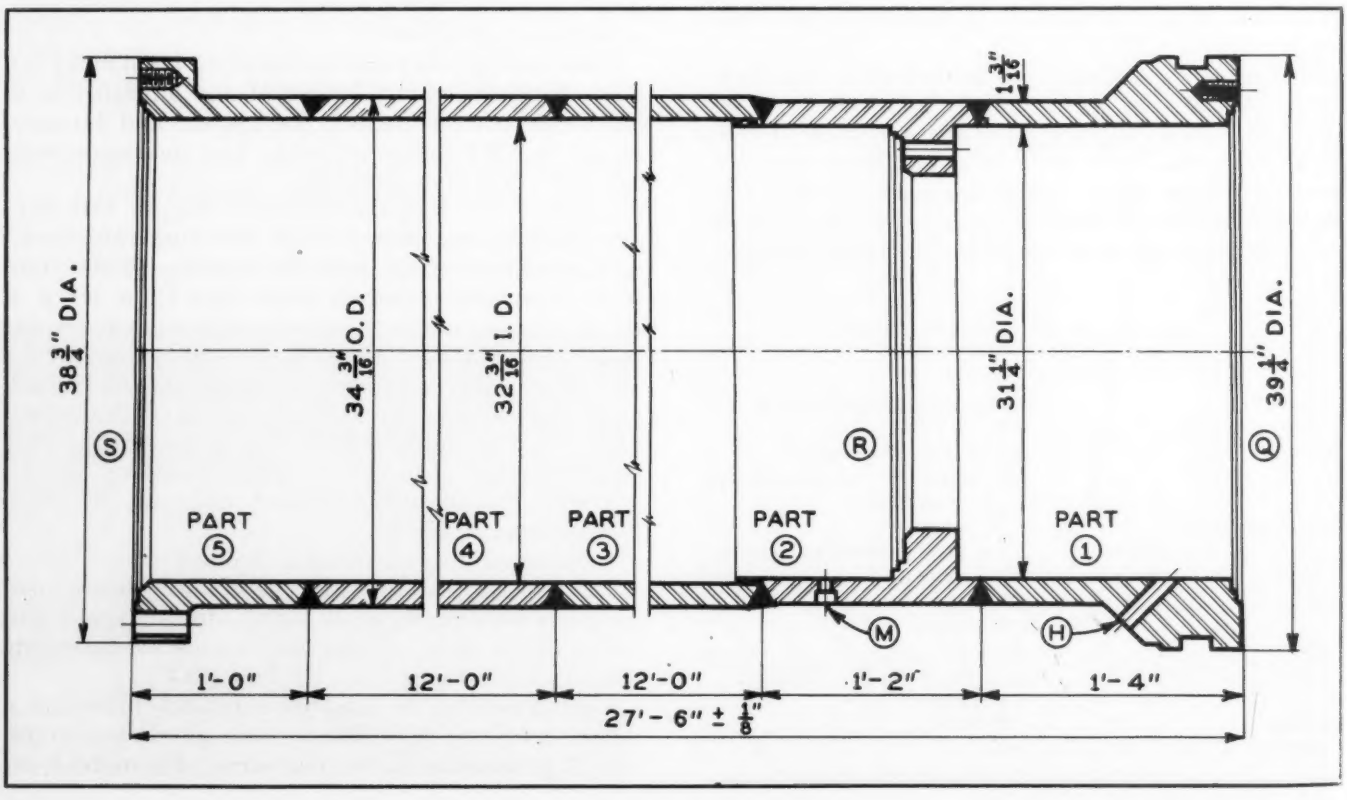


TABLE 4—WELD PROPERTIES

	Tensile, psi	Yield, psi	Elongation, %	R.A., %	Impact, ft-lb	Bend, deg
MANUAL						
Longitudinal bend, weld at center	—	—	—	—	—	120
Longitudinal bend, weld at center	—	—	—	—	—	120
Transverse, all weld, tensile	81700	69300	22.8	52.8	—	—
Transverse, all weld, tensile	79300	70700	18.8	41.7	—	—
Longitudinal weld at center, tensile	76200	43400	—	—	—	—
	—	66500	—	—	—	—
Longitudinal weld at center, tensile	75700	43500	—	—	—	—
	—	66900	—	—	—	—
Charpy weld, center	—	—	—	—	32	—
Charpy, fusion zone	—	—	—	—	40	—
AUTOMATIC						
Longitudinal bend, weld at center	—	—	—	—	—	180
Longitudinal bend, weld at center	—	—	—	—	—	180
Transverse, all weld, tensile	77500	50700	27.1	56.7	—	—
Transverse, all weld, tensile	79200	52500	26.3	57.8	—	—
Longitudinal, weld at center, tensile	76600	50300	—	—	—	—
	—	51800	—	—	—	—
Longitudinal, weld at center, tensile	76700	48900	—	—	—	—
	—	50600	—	—	—	—
Charpy weld, center	—	—	—	—	43	—
Charpy, fusion zone	—	—	—	—	35	—

NOTE: In processing, the welds were magnetic particle inspected after the first pass, stress-relieved by local heat-treatment at 1150–1200 F for 6 hr, and again magnetic particle inspected after the excess weld metal had been machined off.

tory and economical solution was found by utilizing an available metal pattern, and "lagging" up the outside by placing close-fitting wood staves around the circumference of the pattern to increase its outside diameter to the proper size. Refractory sand is rammed around the staves, thus forming the tube mold.

Tube sections are centrifugally cast 34.80 in. OD × 31.56 in. ID × 12 ft 2 in. long. The cast weight is 6900 lb. Pertinent data on casting are given in Table 5.

After tubes were stripped from the mold they were cleaned, inspected, and machined to 34 3/16 in. OD × 32 3/16 in. ID × 12 ft long (approximately). Ends were machined for welding, employing male-and-female joint design with a 1/8-in. radius at the root of the weld groove and the tangential bevels at 20 deg.

Welding Procedure

The two tubes composing the body section were welded first and later assembled by welding to the static cast end pieces to make a completed unit 27 ft-6 in. long.

Manual welding was employed throughout. Tubes were carefully aligned and tack-welded in position in the lathe where fits are made, then placed on welding-rig rollers where the welds were completed. The weld groove was preheated to 300 F, and this temperature

TABLE 5—CASTING DATA FOR STAINLESS-STEEL RETORTS

Orifice size, in.	2
Pouring temperature, deg F	2780
Pouring time, min-sec	3–25
Flask speed at pouring, rpm	410
Casting time, hr-min	1–45
Ram time, min	18
Ladle additions	Carbon-free liquidizer

was maintained during subsequent passes. Standard Type 310 steel lime-coated welding rods were employed. This type of rod is well shielded and has sufficient surface tension to produce the desired convex weld deposition. Procedure was as follows:

First pass, 5/32-in. rod	20 v 100 amp
Second and third passes 3/16-in. rod	22 v 125 amp
Subsequent passes 1/4-in. rod	25 v 155 amp
Current	reverse polarity direct current
Time	12 hr

Skip-welding was employed on the first two passes to eliminate warpage. To obviate any tendency toward cracking, low heat was used with welding progressing uphill. Heavy electrode deposit was made enabling the molten metal to run down under a heavy slag. Electrodes were positioned about 15 deg from the vertical and normal to the tube axis. A slow puddling arc break was employed to prevent crater cracking. Each pass was cleaned of slag, wire-brushed, and mechanically stress-relieved by pneumatic-hammer peening.

Assembling the Unit

These fabricated units are pressure vessels for high-temperature service. Consequently, no heat-treatment is required and welds were not stress-relieved. Due to the weight, lengths, and precise machining required, it was necessary to machine component parts, fabricate into subassemblies, and finally weld these assemblies together to make the complete units. In view of the tight machining tolerances and the necessity for precise alignment, this was no easy matter. Fabrication procedure was in the following order: (Numbers refer to component parts in Fig. 13.)

1 Rough-machine sections 1 and 2.
2 Weld section 1 to section 2.
3 Machine inside and outside of sections 3 and 4 separately.
4 Weld section 3 to section 4.
5 Rough-machine section 5.
6 Weld section 5 to sections 3 and 4.
7 Finish-machine section 5 after welding to sections 3 and 4.
8 Finish-machine sections 1 and 2, and test between faces Q and R.
9 Drill holes H in section 1.
10 Weld sections 1 and 2, sections 3, 4, and 5.
11 Test between faces R and S.
12 Drill holes M in section 2.

The subassemblies and completed vessels were hydrostatically tested at 300 psi and air-tested at 100 psi, while submerged in water. The alignment test required that a 32-in-OD × 2-ft-long wooden plug slide freely through the 32 3/16-in-ID cartridge. Ends had to be square with each other. Not more than 1/4 in. maximum out of alignment was permitted. The assembled cartridge weighs 12,500 lb.

ATTRACTIVE PROGRAM FEATURES WISCONSIN REGIONAL MEETING

AN INTERESTING and extensive program will bring many mid-west foundrymen to the eleventh annual regional foundry conference at the Schroeder Hotel, Milwaukee, February 12-13, sponsored jointly by the A.F.A. Wisconsin chapter and the department of mining and metallurgy, college of engineering, University of Wisconsin, Madison. R. C. Woodward, Bucyrus-Erie Co., Milwaukee, and A. C. Haack, Wisconsin Grey Iron Foundry Co., Milwaukee, are chairman and co-chairman, respectively, of Thursday's sessions. On the following day Professors E. R. Shorey and Geo. J. Barker of the University will act as co-chairmen.

As many as six technical sessions will be conducted simultaneously each day, the first from 2:15 to 3:45 pm; the second 4:00 to 5:30 pm; the third 10:00 to 11:50 am; and the fourth 2:00 to 3:30 pm. Entertainment and relaxation will be provided in the form of a luncheon and dinner Thursday and a luncheon Friday. The technical program is laid out in accordance with the chapter's sectional meetings with six divisions; namely, gray iron, steel, malleable, non-ferrous, pattern and technical.

The Honorable F. B. Keefe, Congressman, 6th District, Wisconsin, will be the dinner speaker on Thursday and his subject is "Foreign Relations." Luncheon on Friday will find A.F.A. Past Director G. K. Dreher, executive director, Foundry Educational Foundation, Cleveland, addressing the members and guests.

Program for the conference is as follows:

Thursday, February 12

9:00 am—Registration

10:00 am—Opening Address
Dean M. O. Withey, College of Engineering, University of Wisconsin.

10:30 am—General Meeting
Time—Motion Analyses—Foundry, A. B. Segur, A. B. Segur & Co., Oak Park, Ill.

12:15 pm—Luncheon Meeting

2:15 pm—Gray Iron
Low and High Temperature Properties of Mold and Core Sand Binders, J. A. Gitzen, Delta Oil Products Co., Milwaukee.

2:15 pm—Malleable
The Availability of Proper Raw Materials for Malleable Iron, J. H. Bemis, Pickands Mather and Company, Chicago.

2:15 pm—Non-Ferrous
Proper Selection of Alloys, Wm. Romanoff. H. Kramer & Co., Chicago.

2:15 pm—Pattern and Technical
Precision Casting, Kenneth Geist, Allis-Chalmers Mfg. Co., Milwaukee.

2:15 pm—Steel
Round Table Discussion on Steel Foundry Practice, H. F. Taylor, Massachusetts Institute of Technology, Cambridge.

4:00 pm—Gray Iron
The Use of Large Sizes of Anthracite Coal in Cupola Operations, Prof. Reagan, Pennsylvania State College, State College.

4:00 pm—Malleable
Malleable Annealing Cycles in Batch Type Ovens, C. M. Lewis, Badger Malleable & Mfg. Co., South Milwaukee.

4:00 pm—Non-Ferrous
Are You Going Broke, R. L. Stone, First Wisconsin National Bank, Milwaukee.

4:00 pm—Pattern
Pattern Purchasing, G. L. Hartman, Milwaukee Flush Valve Co., Milwaukee.

4:00 pm—Steel
The Use of Oxygen in Open Hearth and Electric Furnaces, G. V. Slottman, Air Reduction Sales Co., New York.

4:00 pm—Technical
Universal Sand Mix for Various Types of Metal, R. E. Morey, Naval Research Laboratory, Bellevue, Washington, D.C.

8:30 pm—Banquet
Foreign Relations, Hon. F. B. Keefe, Congressman, Sixth District, Wisconsin.

Friday, February 13

10:00 am—Gray Iron and Technical
Sand Grain Distribution, C. A. Sanders, American Colloid Co., Chicago.

10:00 am—Malleable
A Periodical Type Malleable Annealing Oven, R. N. Cole, Canton Malleable Iron Co., Canton, Ohio.

10:00 am—Non-Ferrous
Typical Foundry Problems in Casting Aluminum Alloys, R. A. Quadt, Federated Metals Div., American Smelting & Refining Co., Barber, N. J.

10:00 am—Pattern
Unusual Patterns, H. Wade, Fairbanks-Morse Co.; G. C. Krueger, Allis-Chalmers Mfg. Co.; and A. Fisher, Chas. Jurack Co., all of Milwaukee.

10:00 am—Steel
Steel Foundry Sands and Their Relation to Casting Defects, H. F. Taylor.

12 noon—Luncheon
G. K. Dreher, executive director, Foundry Educational Foundation, Cleveland.

2:00 pm—Gray Iron
What Do You Know About New Materials and Methods of Production, R. G. McElwee, Vanadium Corp. of America, Detroit.

2:00 pm—Malleable
Incentive Inducements for Men to Work in Malleable Foundries, H. R. Williams.

2:00 pm—Non-Ferrous
Information Please, G. K. Dreher.

2:00 pm—Pattern
Coordinative Function of Pattern Equipment and Castings, A. F. Pfeiffer, Allis-Chalmers Mfg. Co., Milwaukee.

2:00 pm—Steel
Post War Developments and Progress in Steel Foundries, C. W. Briggs, Steel Founders' Society, Cleveland.

2:00 pm—Technical
Use of Statistical Control in the Foundry, G. R. Gardner, Aluminum Co. of America, Cleveland.

Chattanooga Plans For New A.F.A. Chapter

FOUNDRYMEN IN the Chattanooga, Tenn., area have formed a Steering Committee to consider the formation of a new A.F.A. chapter, and have announced that a general organizational meeting of all foundrymen in the territory will be held at the Patten Hotel, Chattanooga on February 11, according to A. D. Willis, U. S. Pipe & Foundry Co., Chattanooga, Chairman, Steering Committee.

Periodically over the past several years chapter organization has been discussed in this area, and the Steering Committee has already received enthusiastic support from foundry executives and operating men. In addition to Chairman Willis, other officers of the Committee are as follows: *Vice-Chairman,* Frank Anderson, Chattanooga Implement & Mfg. Co., and *Secretary-Treasurer,* W. C. Cate, Crane Co.

Other members: Porter Warner, Porter Warner Industries; C. B. Sounders, Southern Ferro Alloys Co.; J. Armstrong, Obermeyer Co.; Sam Northington, Combustion Engineering Co.; Karl Landgrebe, Wheland Production Foundries; Wm. Greiser, Ross-Meehan Foundries; and J. B. Crimmins, Mills & Lupton Supply Co.

Want A.F.A. Chapter

Chairman Willis reports that his committee was organized at a meeting December 19 and following unanimous agreement the foundrymen in a wide area were contacted by members of the committee. Results reported at a second meeting, January 7, proved most favorable, and an open meeting was scheduled for February 11. At that time all present will be asked to vote on the question of chapter formation and if approved chapter petition will be formulated for prompt presentation to the American Foundrymen's Association Board of Directors.

AN AMERICAN OBSERVES EUROPEAN FOUNDRY METHODS

R. E. Fisher, Jr.
Bonney-Floyd Co.
Columbus, Ohio

ON A RECENT EUROPEAN TOUR the writer obtained considerable information as to the physical conditions and practices of foundries in the various countries visited. With few exceptions the industry was found to be laboring under the burdens of material shortages and obsolete and worn-out equipment. Modern foundry practices were the exception rather than the rule.

In England the best of treatment was received from both the people and the companies visited. All the co-operation and information one could hope for was freely given—costs, sand mixes, analysis and practices. It appeared that the British foundry industry is doing everything possible to re-establish itself. Bentonite, cereal binders, alloys and American equipment are almost unobtainable. The terrific dollar shortage practically places these articles on a "forbidden" list.

Hard usage in war production caused most damage in the British foundry industry. Instead of expanding, the industry used existing equipment to the utmost, with the result that most of it is worn out. During the bombing it got off lightly—in the Sheffield area three hotels and five department stores received direct hits, while not a foundry was touched.

British Melting Methods

In melting, the favorite medium seemed to be the electric furnace with converter duplexing a close second, the chief objection to the latter method being its higher cost due to scrap, coke and labor. Only a few high-frequency furnaces were seen, none of which were over 1000-lb capacity. The Edgar Allen Manganese Co., which pioneered the electric furnace process, had probably the best installation. All of the electric furnaces were basic with the exception of one 10-ton furnace at F. H. Lloyd Co., which has been operated with the acid process for over a year, with not too good results. It was felt that this was due to the very poor, but cheap, scrap used.

In the molding and core departments the foundries seemed to do quite well in spite of the many handicaps. Several sand mixtures were used, based largely upon straight silica sand, which was hauled right off the beaches and dried in the shops, and a "schamotte type" material found in Northern Scotland. Most of the silica sand was used in an "oilless" dry sand mix, green sand being used only on very small work. All of the schamotte was dried in ovens.

Perhaps the most interesting material used in the sand mixes was a plastic-like mixture of linseed oil and binder, which when added to sand gave it the proper amount of both oil and bond. Most of this type of core sand was milled in a machine called a "rottoil" mixer, the principle of which seemed to be flowing the sand under blades, working the core compound into the sand rather than mulling it on.

The oilless dry sand mixture mentioned usually was nothing more than bentonite, silica sand, and a portion of naturally bonded sand for green strength. The use of silica flour in foundries is not permitted by the British government. Cement is used entirely in two large foundries. Both places seemed quite satisfied with the material, and claim a much lower casting cost as a result of its use.

Scottish Foundries

In Scotland several iron and steel foundries were visited, and these people, in particular, gave the impression of being good foundrymen, and really going after their business. It was there that a quite different type of pneumatic molding machine for making gray iron was seen. Two men to a machine produce a mold every 48 sec with a casting weight of up to 3 lb.

Also, at this same foundry, they were doing some interesting valve work. A small valve with 8 in. diameter flanges 1¼ in. thick, and a ½-in. section throughout with 1-in. seats was cast with only three 2-in.-square heads. This was done by making all the faces and sides of the flanges in cast iron chills. The casting was sectioned and shown to be solid throughout.

The Kryn & Lehey foundry, near London, is doing considerable experimental work both in molding materials and feeding. The pressure pill in an airtight head is their development. This appeared to be nothing more than an explosive substance surrounded by a refractory material which requires a known amount of heat for ignition. The real secret of the process, and as yet not too well developed, seems to be the timing of the ignition charge and the proper stoppage of the gate to prevent the metal from blowing back. Yields as high as 95 per cent have been reported with this process, but at the time of the visit it was not being used in actual production.

The British, in direct opposition to their neighbors on the Continent, seem to prefer the round head almost exclusively, stating that the square head tends to solidify too rapidly. On the other hand, several shops were found using a square gate in conjunction with a round head, the purpose not being readily apparent.

Another noticeable difference in their casting design

is the absence of brackets, and the castings were free from cracks. It was explained that this was possible because of certain qualities of basic steel which are not found in acid steel. This was particularly true in large turbine castings.

All in all it appeared that the British are good foundrymen; given good equipment, money and time they are sure to win out. At present, much effort is being directed toward improvement of the British casting business.

French Foundries

The French foundry industry is undoubtedly the weakest of any in the large countries on the Continent. Equipment is old and obsolete, the foundies were badly damaged by Allied bombing, and methods, in many cases, are antiquated.

It was more difficult to secure permission to visit French foundries than in any other place in Europe. However, once in, they were very friendly and desirous of information on American foundry practice.

They do have an excellent foundry society, so far as organization and personnel are concerned, but the equipment is very poor, and research quite limited. This organization seems to look to America as its chief source of information and help.

Perhaps the most interesting foundry visited in France was French Schneider works at LeCreuset, famous in the two wars for its artillery castings. It has over 15,000 employees in steel, iron and aluminum foundries and several roll shops. The steel foundry was divided into many buildings, with outside sand blast and heat treating, and the melting shop was almost three blocks away from the foundry. Four 10-ton electric furnaces were used, two of which were almost totally destroyed by the Germans when retreating from France. Part of the tonnage from these furnaces is used in ingots for the mill.

All molding, with the exception of three bumpers, was by hand, with several sand mixes. For large work, from one to 50 tons, they used a crushed bauxite with clay, washed with silica flour and dried in the oven for 12 hr. In complicated work this mixture is made quite muddy with heavy additions of water, and practically "slapped" on the face of the pattern.

These molds are dried for two days at 750 F. This system seemed to work out quite well, and certainly made complicated molding much easier. For lighter work, either oil sand or cement is used. The oil sand is a washed and dried silica base with linseed oil binder.

Cement Molding

In the cement process they use a quick-drying mix, which sets up in less than four hours. Before starting a cement job, they lined up all equipment necessary, several extra men, then worked like fury until the job was done. This extra labor cost, plus the fact that it is apt to "burn in" on any difficult section or radius, seems to be the reason for the restricted use of the process.

There was no mechanical shakeout for either large or small work; all molds were knocked out by hand. The cleaning department was very backward, without any system or progression of work. However, the finished castings, many of which are rough machined before shipping, did look good, even though the yield was quite low. The foundry manager stated that their production is almost up to 1939 quantity standards.

Belgian Foundries

Belgium is certainly one of the most industrious and productive countries in Europe. This was the only place where productive effort and ability equal to American standards were encountered. Due to the great necessity for imports, about 90 per cent of the steel casting production is exported to maintain a balance of trade. Considerable tonnage is shipped to England, in spite of the 30 per cent duty levied on castings by that country. The foundry industry did not suffer too much from the German occupation.

The chief obstacle, even with good import trade, is the lack of sources for material and machines. More and more equipment is being purchased in the United States. They now turn to America for all mechanical data and research work.

Manpower, too, is quite a problem. Men do not want to work in the foundry—wages are low, a highly paid molder receiving 65c an hour. At one foundry transportation is provided to and from work, as far as 25 miles, in order to induce men to work there. However, the labor they do have is good, and skill in molding is particularly high.

Two of the principal steel foundries—John Cockerill at Liege and Emile Henricot, Brussels—were visited. Both places are busy on large work, but lack orders for smaller castings. Their chief asset is the unlimited source of naturally bonded sand. It cost them only a little more than freight charges, and requires no milling or additions. In medium and larger classes of work, the molds are either baked in an oven or poured green, depending on their complicity. Less complicated cores are also made with this sand.

It would be interesting, if it were economically possible, to import some of this naturally bonded sand into the United States, for there is nothing in this country that equals it, particularly for steel.

Belgian foundries also have several good sources of silica sand, which they use chiefly in dry sand cores. Very little work has been done as yet in synthetic green sand, and they were quite interested in any information available, especially in casting manganese steel.

Flame Hardening

One operation, of which they were quite proud, was their system for making frogs and crossings. The castings were made in dry sand in a nickel-chrome-moly alloy, and a machine cut of about $\frac{3}{16}$ in. taken off the rail surfaces. They were then immersed in water to within $\frac{1}{2}$ in. of the machined surface, and flame hardened with a torch. The tensile strength of this hardened portion ran about 120,000 psi. Judging by reports from the field, this system was quite successful.

Also in Liege, Belgium, a most interesting iron foundry was visited. Located in the heart of the city, where it has stood for five generations, it makes all sizes of gray iron castings. Equipment does not include pneumatic tools or sand blast, and few flasks are available. All castings are chipped by hand and cleaned with a wire brush. The present owner is foundry foreman, chief melter, sales engineer and board of directors.

All alloy work in the Henricot foundry at Brussels was melted in high-frequency furnaces, one furnace melting up to 2500 lb in 2 hr. This was the largest

observed in Europe. As in most cases on the continent, all shakeout was by hand.

Czechoslovakia

After considerable difficulty with governmental red tape, permission was received to visit the Skoda works in Czechoslovakia. More than 80 per cent of the Skoda works was destroyed by American bombing, but it has now been rebuilt almost to pre-war standards. Most of the credit for this is given to the government control plan. About 20,000 people work for Skoda, making everything from small gray iron castings to automobiles, cranes, refineries and locomotives.

The steel foundry is divided into three parts—light, heavy and alloy. Casting weight varied from a fraction of a pound to 150 tons. Castings from 25 lb up were molded by hand on the floor, no power molding machines being used. Silica sand, a substance called "lupec" and schamotte were used for molding material. Lupec, as far as could be determined, is a refuse found between veins in local coal mines. It is ground and milled with clay and graphite. It did give a very good finish on some quite difficult castings.

In smaller work, the molds were made of silica sand or lupec, the difficult sections being faced with schamotte. The greatest difficulty at present is the lack of a suitable wash, as the formerly used schamotte mixtures from Germany are no longer available. Also, their clay is very poor, and to circumvent this facing sand is made as weak as possible. All molds are relieved soon after pouring by removing the cope flask and driving rods into the drag.

The light casting shop was almost entirely mechanical, equipped with a German machine that squeezed while it jolted. The manager was quite enthusiastic about these units. All work here was in green sand. The sand used by the steel foundry is milled in a separate building at a considerable distance from the foundry. After milling it is delivered on railroad cars to the various unloading stations.

In the large shop there were six Siemans open hearth and three electric furnaces, all basic and dolomite lined. These also handled the great number of ingots poured each day for the Skoda rolling mills. During the war, two open hearths were operated on the acid process, making the famous Skoda gun barrel for Germany. Scrap is quite inexpensive but of poor quality. This company undoubtedly lives up to its reputation for good castings.

Switzerland

In the manufacture of quality castings, Switzerland probably more closely approaches the United States than any other European country. Their equipment, in most cases, is as good or better than American equipment. Only on the material end is Switzerland shy.

All operations are directed to the finished product. Much of the work done on a casting before it is shipped would be considered quite unnecessary in the United States. However, their customers have come to expect a finely worked article and, even with the high cost accompanying such work, want it that way. Naturally, on a man hour per ton basis, their output is quite low, and one sees large shops with a low production rate in relation to the amount produced by a shop of comparable size in the United States.

Switzerland is far ahead of the rest of Europe in equipment, both for laboratory and shop. Much of it is made right in Switzerland, or came from Germany before the war. The shops are up-to-date, neat and orderly. Much has been done to improve conditions for the men, as Switzerland is short of man power and must make foundry work as attractive as possible in order to keep supplied with help.

In the foundries, melting was done with both electric furnaces and high-frequency units. High-frequency melting is still rather new to them, but much information is being received from the Italians, who lead Europe in this method. Scrap at the present time is poor, a great amount of it being old artillery shells and other scrap. Several roofs have been blown off furnaces as a result of powder left in the shells. Average cost of scrap is about $50 per ton, American money. Pig iron is even more difficult to obtain and expensive, since Switzerland has only one blast furnace and no natural source of ore.

Due to the power shortage in one foundry visited, all furnaces were shut down in the afternoon and not started until one o'clock in the morning, which brought the only heat out about 7:00 am. The furnaces were charged by taking out the electrodes, removing the roof with a crane and dumping the charge in with buckets.

Apprentice System Used

Molding and core practice is very good—still using the apprentice system, they have a high degree of skill in the molders. In large work, one man is assigned to the job and he does all of the work—makes the mold, dries it; in many cases he makes the cores, sets them and closes the mold. One man is often on the same mold for as long as six or eight weeks. All of the facing is delivered in pack baskets which the men carry on their backs, and before a job is started a man knows just how much material he will use.

Feeding and design of castings seems to follow a much different pattern than that used in American foundries. The practice is to use as few ingates as possible, with at least two sources of metal. On water turbines, for instance, instead of many ingates around the joint they have just two on each end.

Iron foundries, too, were producing excellent work. An interesting feature was a preference for the duplex system in melting. A great saving in coke was claimed, as well as better alloying when necessary. In most cases, the charge is melted in the cupola to the specification required, and the electric furnace used only to raise the temperature. One foundry had a good air dried sand mix for complicated core work. The core was rammed up, left in the box overnight, removed hard in the morning, and baked for only 6 hr.

Conclusion

In many respects European foundry practice was found to be similar to the American technique. In general, the lack of modern equipment and the poor quality of raw materials constitute formidable obstacles in the path of the European foundry industry in its efforts toward rehabilitation.

Consolidation of the gains made in the many localized efforts to re-established productive capacities and quality standards of individual foundries should, in time, benefit the entire industry.

CULMINATE SEVEN YEARS' WORK IN PUBLISHING DEFECTS BOOK

ONE OF THE most active committees of the Association, the Committee on Analysis of Casting Defects, has successfully completed its task of publishing a comprehensive manual ANALYSIS OF CASTING DEFECTS. An objective of this committee since 1940, this book is the efforts of seven years of committee work.

The committee originally was organized as a general A.F.A. committee to make a study of castings defects following the procedure of the former Non-Ferrous Division Committee in compiling its report, "Analysis of Non-Ferrous Foundry Defects.*"

After a review of the project, the members decided to limit their activities and investigations to gray iron castings, however, this book is valuable to all foundrymen.

Gray Iron Defects

Only four of the defects described (mass hardness, hard spots, inverse chill and kish) are peculiar to gray iron while the others occur at some time in all foundries.

At the outset of the project, the committee compiled a list of over 30 defects; there are 31 basic casting defects listed and described in this new A.F.A. publication. Each defect is defined in terms which are simple yet sufficiently complete to make the defect recognizable. Illustrations show typical defects and supplement the definitions.

The list of defects is shorter than the original number published in the November, p. 16, 1941 issue of AMERICAN FOUNDRYMAN.

Committee Organized in 1940

The present gray iron committee was organized in 1940 at the annual convention of the Association in Chicago. A five-man board consisting of W. A. Hambley, E. J. Carmody, F. L. Hintz, C. C. Kawin and A. S. Nichols realized the committee would need help and offered to sponsor it. These men were especially helpful during the formative period, furnishing a place to meet and discuss, acting as coordinators and performing some of the practical foundry tests.

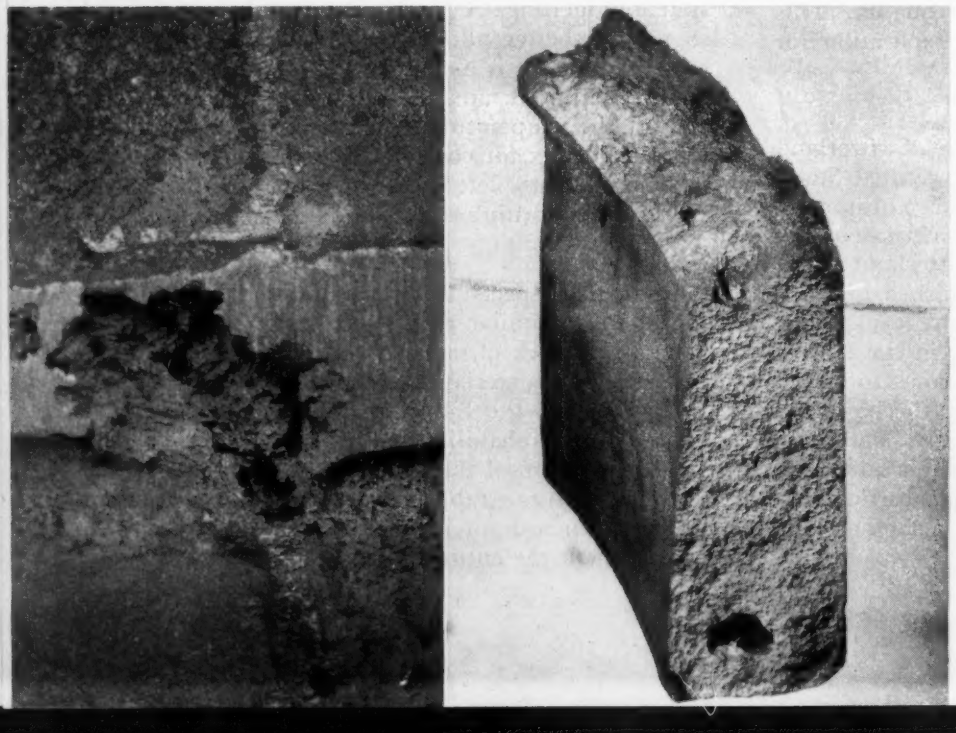
Much of the detailed study of casting defects was accomplished in the foundries of the Allis-Chalmers Mfg. Co., Milwaukee, through the cooperation of J. M. White, vice-president, Past President A.F.A. Wisconsin chapter H. E. Ladwig, works manager, foundry div., and J. T. Jarman, general superintendent of the research department. The photographs are the work of Rexford Krueger, chief metallographer, and his staff.

Former committee members included: A. J. Busch, C. C. Kawin Co., Chicago; R. K. Glass, Republic Steel Corp., Buffalo, N.Y.; F. L. Hintz, first committee secretary, formerly of Illinois Clay Products Co., Chicago; J. L. Love, formerly of Battelle Memorial Institute, Columbus, Ohio; C. V. Nass, Pettibone-Milliken Corp., Chicago; A. S. Nichols, Illinois Clay Products Co., Chicago; W. G. Reichert, consulting engineer, Newark, N.J.; and F. L. Weaver, Great Lakes Foundry Sand Co., Detroit.

Personnel of the final committee is as follows: *Chairman,* W. A. Hambley, Falls Mfg. Co., Menominee Falls, Wis.; *Secretary,* A. S. Klopf, The Western Foundry Co., Chicago; G. W. Anselman, Goebig Mineral Supply Co., Chicago; T. E. Barlow, Eastern Clay Products, Inc., Jackson, Ohio; E. J. Carmody, C. C. Kawin Co., Chicago; W. B. McFerrin, Electro Metallurgical Co., Detroit; F. L. Overstreet, Illinois Clay Products Co., Chicago; and Charles Zahn, Vilter Mfg. Co., Milwaukee.

* TRANSACTIONS, American Foundrymen's Association, Vol. 46, pp. 881-888, (1938).

Typical of the 101 illustrations in the defects book are these photographs of blows. Left—Blow caused by hard core and insufficient venting. Right—Blow caused by cold metal.



Birmingham Chapter Plans Conference

THE SIXTEENTH annual foundry practice conference of the A.F.A. Birmingham District chapter will be held at the Tutwiler Hotel, Birmingham, February 12-14. The committee in charge anticipates that approximately 700 foundrymen will attend this event.

The five technical sessions will be interspersed with luncheons, a management and national officers meeting and the annual banquet.

Honor guest of the conference will be A.F.A. National President Max Kuniansky, Lynchburg Foundry Co., Lynchburg, Va. He will be the main speaker at Thursday's luncheon.

Gosta Vennerholm, Ford Motor Co., Detroit, will be one of the main technical speakers and will present a talk on "Production of Automotive Type Gray Iron Castings."

Dr. J. T. MacKenzie and C. K. Donoho, both of American Cast Iron Pipe Co., Birmingham, are program chairman and vice-chairman, respectively, of the conference.

McFERRIN AND PLANT TOURS FEATURE ONTARIO MEETING

THE ONTARIO chapter held its annual two day Western Ontario meeting, December 5 and 6 at Windsor. Plant visitations were scheduled for both days and on the evening of December 5 a technical meeting was held at the Prince Edward Hotel, Windsor.

Amond the various plants inspected were the Auto Specialties Mfg. Co., Ltd.; Bryant Pattern & Mfg. Co., Ltd.; Ford Motor Co. of Canada, Ltd.; and Walker Metal Products, Ltd.

A.F.A. Ontario Chapter Chairman James Dalby, Wilson Brass & Aluminum Foundries, Toronto, was the presiding officer at the technical session. Speaker of the evening was Wm. B. McFerrin, Electro Metallurgical Co., Detroit, who spoke on "Foundry Defects."

A.F.A. National Director E. N. Delahunt, Warden King, Ltd., Montreal, Que., preceded Mr. McFerrin's talk with an invitation to the 150 members and guests to attend the 52nd Annual A.F.A. convention and exhibit in Philadelphia, May 3-7.

Mr. McFerrin remarked that the production of gray iron castings in the United States and Canada, in 1946, was approximately 14,000,000 tons. If the percentage of scrap produced during the year had been cut by only one per cent, it would have resulted in an additional 140,000 tons of castings available for industry, or, as expressed in monetary values, a savings in excess of $25,000,000.

To correct casting defects, Mr. McFerrin said, it is necessary to call in all persons in the organization who are familiar with each operation and view the castings; consider all the facts, fully utilizing all the equipment at your disposal, not forgetting the record file to aid you in reaching an honest decision; and consider them with an open unbiased mind.

Details of the causes of the 31 possible defects in gray iron castings and remedies are covered thoroughly in the newly published A.F.A. book, ANALYSIS OF CASTING DEFECTS, and to which Mr. McFerrin made many outstanding contributions. He served on the A.F.A. Analysis of Casting Defects Committee which compiled the data and information contained therein.

Following the technical dissertation, John Perkins, Ford Motor Co. of Canada, Ltd., thanked Mr. McFerrin for a most enlightening discussion of such a vitally important subject. This was followed by the showing of a motion picture.

MIT Working To Form A.F.A. Student Chapter

THE POSSIBILITIES of establishing a fifth A.F.A. student chapter, at the Massachusetts Institute of Technology, Cambridge, are being investigated by Howard F. Taylor, professor of mechanical metallurgy, at the Institute.

Mr. Taylor is active in the A.F.A. Educational Division being a member and chairman of various subcommittees. He is also well-known for the work he performed while affiliated with the Naval Research Laboratory, Washington, D.C., and his papers have been published in a number of A.F.A. publications.

Present at the Western Ontario meeting were the following (starting left) A.F.A. Detroit Chapter Chairman W. W. Bowring, Frederic B. Stevens, Inc.; J. E. Foster, A.F.A. Headquarters, Chicago; guest speaker Wm. B. McFerrin; James Dalby; and Ontario Chapter Secretary-Treasurer G. L. White, Westman Publications Ltd., Toronto.

IDENTIFY CASTING DEFECTS

J. O. Vadeboncoeur
Pontiac Motor Div.
General Motors Corp.
Pontiac, Mich.

AMONG THE USEFUL TOOLS which the foundryman has at his disposal to aid him in producing sound, high quality castings is the laboratory. Too frequently the true function of the laboratory is not clearly understood by the practical foundryman, and often he develops an aversion toward bringing his problems to the attention of laboratory personnel. At times a laboratory man may speak a language which is too little understood by those whose chief concern is production, and people are apt to misunderstand those whose ideas they do not fully grasp. Perhaps, too, the laboratory man has sometimes been guilty of masking his own ignorance about a problem with the ambiguity of highly technical phrases of small significance.

But let us consider that a cooperative attitude is desirable, and see just what a foundry can gain from the utilization of a fully equipped, well staffed laboratory.

It is the writer's belief that at least five per cent of any battle is the knowledge of the true character of his opponent. Then, in the ever present fight to search out and eliminate foundry defects, it is a step on the way toward the successful solution of a problem if we can say positively that any particular defect was caused by gas, sand, shrinkage, or other clearly defined source.

An attempt will be made to point out some of the general clues which lead to positive identification of defects. The remedies will be left to the production man whose knowledge of local conditions best fits him to take the steps necessary to eliminate the causes of the defects.

The first three steps in detecting the cause of any trouble are:

1. Get all the facts.
2. Consider them with an open, unbiased mind.
3. Fully utilize all the equipment available, not forgetting the record file, to aid in reaching a decision.

Defects Caused By Included Matter

First to be considered are defects caused by included matter, the three "S's" of trouble—slag, sand, and shot. The positive identification of slag in gray iron requires the most exacting technique in the preparation of the metallurgical specimen. It is essential that the sample be polished for only a short time in order that the soft, weakly adherent slag particles can be retained for examination. If it is suspected that slag or other included matter is present in a section, polish the included matter and forget the iron. A beautifully polished sample may pass the ultimate requirements of a few college laboratories, but a hole in superbly polished metal will tell nothing about the nature of the included matter.

Although specific determination of the individual constituents in the structure of an inclusion is often desirable, the first step is to retain the included matter and thus permit identification as slag, sand or shot.

Slag is nonhomogeneous, and after solidification will contain oxides, silicates, or sulphides mixed together with little or no order. It is amorphous and will fill voids or adhere to already solidified portions of a casting. Identification of the specific slag particles is quite simple with a microscope by use of the well-known methods of Campbell and Comstock,[1] or by following the more recent work of Wohrman.[2]

The first clue, then, is that slag is the only kind of included matter which is both amorphous and heterogeneous. A study of locations in which slag defects usually are found is also an aid. Slag has a high freezing point and is lighter in weight than the molten metal. It floats on the surface of the iron.

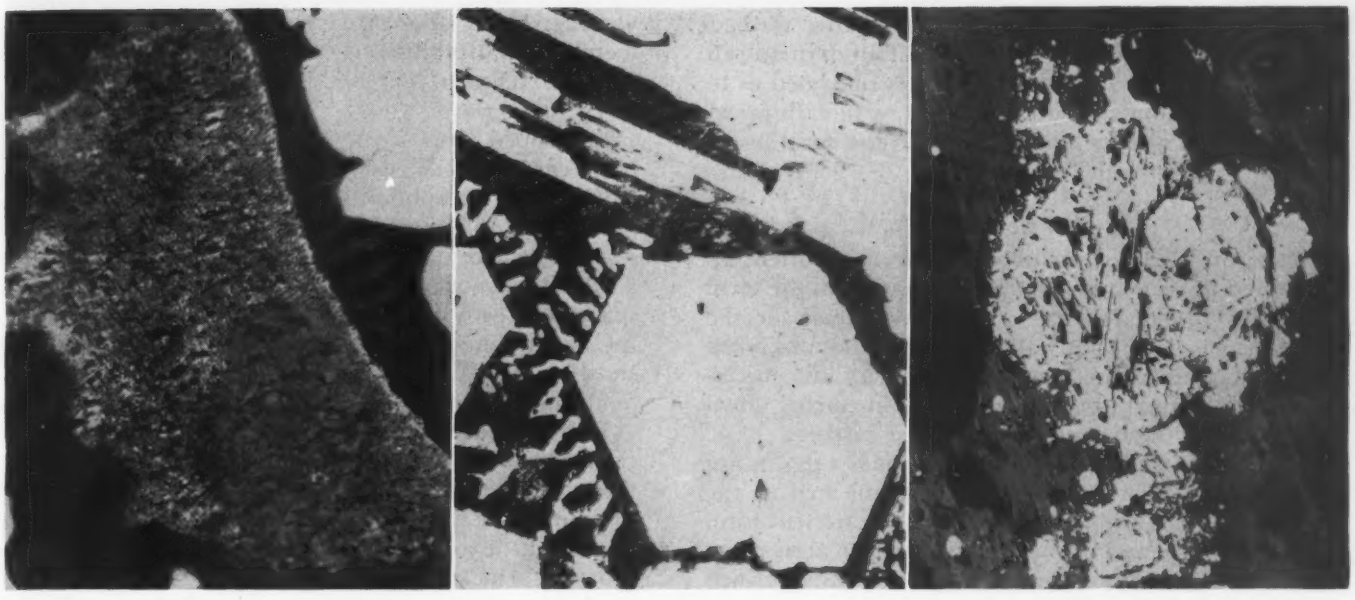
Hence, slag particles are often found at points where the molten metal turns a corner in its journey through the mold. As the metal changes its course the slag is retained at some particular point, either by impingement or through a skimming action. If a thin shell of metal has formed upon the core or mold surface, the slag particles will not be easily found. But if the skimming action has retained the slag on the surface of the casting, the inspection department will more often than not classify the imperfection as a sand defect.

Cylinder Bore Defects

An incident in the author's foundry will serve to illustrate this point. One week when the foundry was particularly troubled with a defect in the cylinder bore, many samples were submitted for examination. Each had been rejected as a sand hole. Laboratory tests proved that they all contained slag rather than sand. Noting that the trouble occurred in only two of the eight cylinders, the laboratory checked over the charts of sand defect frequency for cylinder bores, which had been accurately kept for the record files. For several years, all scrap due to sand occurred in two particular bores. Suddenly the charts showed that the so-called sand had shifted its preference to the bores in which the current trouble was brewing. Acting on inspiration as much as reason, the foundry records on gating changes were examined. These records indicated that a change in gating had occurred at the same time that the defect shifted to the new bores. Foundry supervision then traced the flow of metal in the mold, and it was discovered that a sharp turn was made at the point of trouble. The metal was impinging on the mold and leaving behind little particles of slag, which upon

[1] W. Campbell and G. F. Comstock, ASTM *Proceedings*, vol. 23, p. 521 (1923).

[2] C. R. Wohrman, ASST *Transactions*, vol. 14 (1928).



Left—Outer border of copper-rich inclusion. Nital etch. X1500. Center—Copper-iron alloy inclusion. Nital etch. X500. Right—Slag containing iron-copper alloy inclusion. Unetched. X100.

building up caused a most objectionable defect. Having found the true nature of the defect, it took but a short time before the cause and remedy were quickly determined, not to speak of complete vindication of unjust charges against the sand department.

Slag will be found more often in the cope than in the drag. We are all aware of the partial segregation of manganese sulphide in the cope portions of a casting. These particles are very small and quite evenly dispersed through the metal as it comes from the spout. On standing they began to rise in the ladle and continue to rise in the mold until entrapped by the advancing front of solidifying iron.

If an inclusion appears to be amorphous, and yet is obviously composed of only one substance, it is well to suspect that foreign material may have been washed into the mold. In one instance the laboratory carefully picked a small quantity of such an inclusion from a scrapped casting. Chemical analysis of this foreign matter was identical to that shown on foundry records for a patching clay used on the lips of the bull ladles. With this information the foundrymen were able to stop a serious scrap threat almost as soon as it had started by a simple adjustment of the clay mixture.

Iron Oxide Inclusions

Another inclusion which appears to be both amorphous and homogeneous is scale, or iron oxide. If a casting has been cracked prior to an annealing or normalizing operation, scale will invariably fill the defect. Proper identification as iron oxide is definite proof that the casting was cracked prior to its entrance into the heat-treating furnace. Magnetic particle testing of large lots at various points in the processing of the casting can then be resorted to for determination of where the castings are being cracked. Improper identification of this inclusion as slag will only hamper the foundryman in his search for the cause of his trouble. A simple identification test consists of etching the metallurgical sample with a 20 per cent solution of stannous chloride for about 10 min. This etchant will completely remove iron oxide from the sample, but will not touch any of the silicates or sulphides in slag.

Penetration of molten metal into voids in the mold or core surface and its subsequent solidifications there results in castings showing adhering sand defects. Burnt-on sand rarely occurs in a gray iron casting, for a strict interpretation of the term implies that the sintering point of the sand has been passed and vitrification occurs at the iron-core interface. Few gray iron castings are poured at temperatures sufficiently high to pass the sintering point, so the term "adhering sand" more nearly describes the condition under discussion.

Sand Defects

Consideration again must be given to the polishing technique, and emphasis placed on holding the sand in the sample. Sand is easily differentiated from slag because of the sharp boundaries delineating each grain from the iron matrix in which it is imbedded. Sand also has a uniform structure. Each grain will appear to be the same, pitted somewhat perhaps by grinding and polishing, but showing no resolvable internal structure.

In one instance where the uniformity of ramming was under debate in consideration of an adhering sand defect, the laboratory carefully sampled and analyzed two of the offending surfaces. The silicon content of the two checked within 0.02 per cent, and removed all doubt about the ramming of the mold from consideration of the problem.

Mold temperature can be considered indirectly in such sand penetration problems by observing the nature of the pearlite in the iron adjacent to the defect. If the pearlite is lamellar, the mold probably cooled normally. However, if tiny spheroids have formed in the structure, the initial temperature was probably so high that the casting cooled more slowly through the pearlitic range due to a slower dissipation of the heat. Careful polishing and magnifications of between 750 and 1000 are necessary to show this difference.

If sand is identified within a casting, rather than at

the surface, it usually is the result of being washed into the mold. Since the experienced foundryman can glean much useful information if he is informed as to the exact location of the sand defect, a metallurgical report should always be specific as to the location of such included matter.

Shot Defects

The third type of included matter most often encountered in a casting is shot. This may be in the form of small, chilled droplets of the base metal, or the particles may be of highly alloyed material of unknown origin. Chemical analysis, together with the microscope, can be used to great advantage in tracing down the source of these causes of scrapped castings.

The addition of an alloy to the charge is a significant cause of shot. Particles may drop to the bed of the cupola where a thin skin of oxide or silicate will form on their surface and prevent their ultimate absorption into the melt. This source of shot is readily verified by chemical analysis.

Droplets, which when analyzed show a high phosphorus content, or considerable steadite in a microscopic examination, are not true shot particles, even though their hard, brittle nature may be equally devastating to tool life.

True shot usually is found on the casting surface or in a corner of the mold where it has been washed by the stream of molten metal. A close study of globules containing phosphorus will show that they are attached to the casting at one point. They will be found in interior cavities where they were extruded during the solidification of the casting.

Gas Defects

A study of these extruded globules and their cavities leads to still another source of foundry scrap—gas.

Gas may be introduced into a casting by improper venting; either absorption or occlusion in the liquid metal; solubility differences at different temperatures; improper cupola practice; rusty scrap, and probably many other ways.

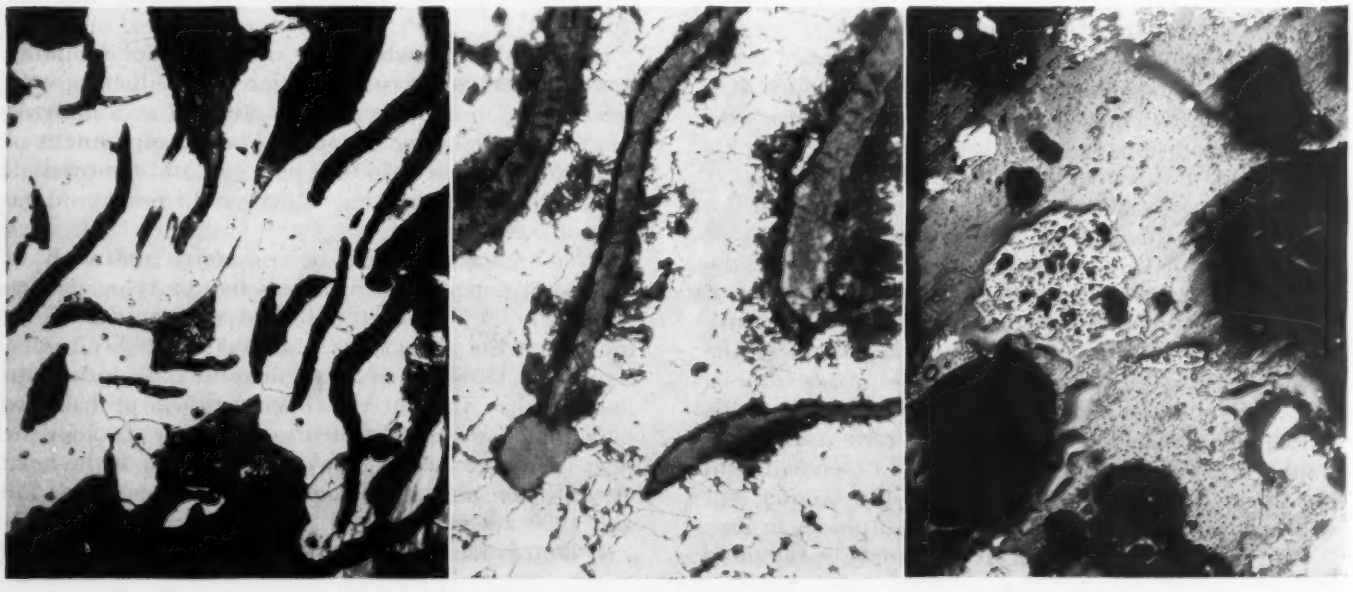
Entrapped gas usually will leave a smooth, shiny, black cavity. As the slowly solidifying metal forces the still molten phosphorous-rich material (which solidifies around 1850 F) to the grain boundaries in a solid section, so here does it extrude into a gas-filled cavity, a mushy mass of phosphorous-rich alloy. However, the space is already gas filled so that the introduction of the steadite increases the pressure, and hence forces the steadite to assume the spherical shape so closely resembling shot.

Either absorbed or dissolved gases will not leave a calling card so easily distinguished. In careful studies, using apparatus capable of governing every variable present in the melting of iron, hydrogen has proved to be one of the most soluble of the gases in molten iron. However, the solubility of hydrogen decreases directly as the temperature decreases. This decrease in solubility causes the gas to escape from within the iron itself during solidification.

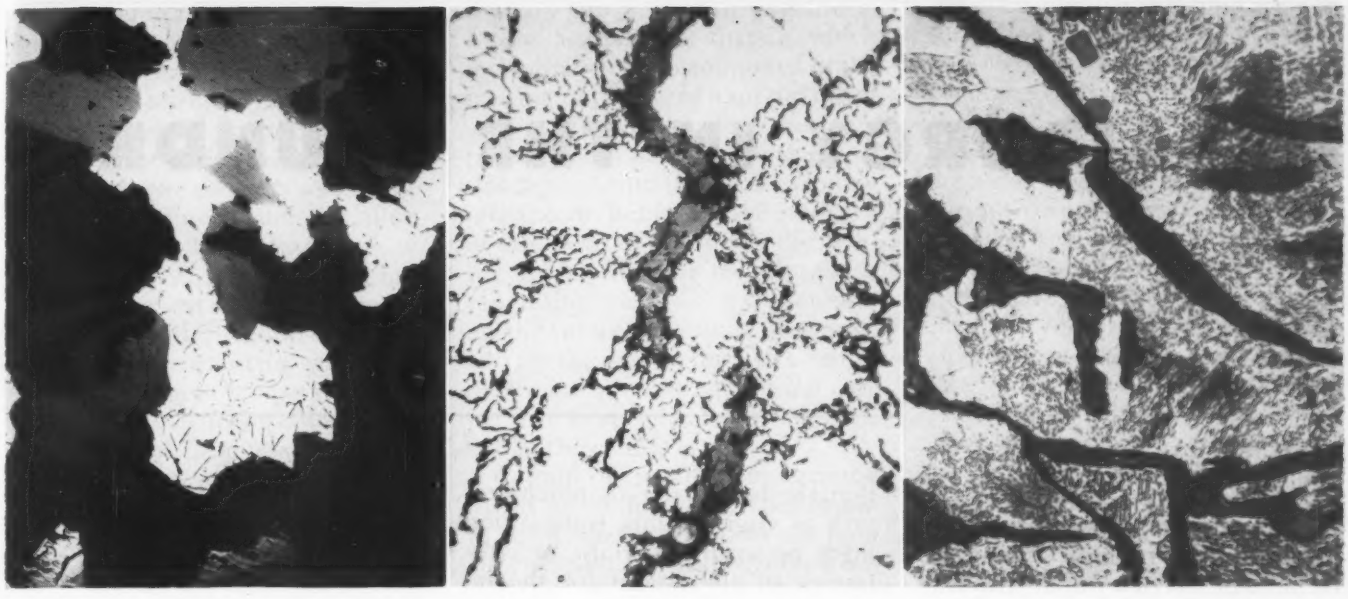
Effect of Gas Pressure

Porosity due to gas is caused by pressure differences between the atmosphere and metal. By careful sectioning and study of both the surface and the porous spot, one can usually see how the pressure has blown the gas through the metal to the surface. A winding pipe line, as it were, transports the gas out of the casting. United States Naval Research Laboratory workers have reported that these pipe lines are often but a thousandth of an inch in diameter. Further, they were able to trace them to the surface in every casting containing the porosity type of gas defect. These workers were further able to prove that bleeding of risers and sprues was directly attributable to atmospheric pressure differences within a mold.

Another defect traceable to gas is that which occurs where the heat given off by burning gas within the solidified metal burns out the metal between the graphite flakes. The hot gas, using graphite as a fuel, actually burns its way to the surface. To discover if this has happened, one must have retained the graphite



Left—Round globules in ferrite grains are silicates formed as reaction products of the molten iron bath. Nital etch. X1000. Center—Manganese sulphide at tip of graphite flake (white constituent is not ferrite). Nital etch. X1500. Right—Slag inclusion. Unetched. X100.



Left—Sand inclusion. Note clear delineation of boundaries and homogeneous structure. X100. Center—Iron oxide in cracked iron. Unetched. X500. Right—Spheroidized pearlite, indicating high pouring temperature and slow cooling through pearlitic range. X1000.

during polishing. True graphite is gray, not black, as the numerous photomicrographs in the literature would lead us to believe. A combination of poor equipment and technique has resulted in many pictures of voids being labeled as graphite. If all of the graphite has been retained, then and only then can the burned-out areas be immediately recognized. The structure of the metal next to these burned-out areas will show a breakdown of the pearlite and, in general, resemble burned iron. A small line will connect each successive flake from the interior to the surface.

Gas pockets just below the surface skin on a casting may be traced to gas which is a reaction product. This surface skin or crust is practically an iron oxide with included impurities The carbon in the molten metal reduces the oxide crust to iron and the gas formed is trapped, pushing downward until a sizeable pocket has been formed beneath the surface skin. This type of gas defect is found more often in open sand castings, where the exposed metal has considerable time to oxidize.

The most difficult type of gas defect to discover is occluded gas. Here we have a casting of sound appearance with no detectible defects. But, the slightest applied stress will cause thin sections to rupture. Thin-sectioned castings containing occluded gases have shattered like glass when dropped from a height of a few feet, whereas the same casting without occluded gas will often bounce when subjected to the same treatment. The only clue to the true cause of such brittleness is the extremely fine fracture of iron containing occluded gases. The source of such gas lies wholly within the cupola itself, and the operation must be carefully checked. It is reported that one foundry producing piston rings completely stopped gas brittleness by the installation of dehumidifiers on the blowers.

Shrinkage Defects

Another source of foundry scrap, to which many of the afore-mentioned defects are often attributed, is shrinkage. Often the physical nature of the defect is so clearly evident that no further investigation is necessary, but frequently small internal shrinks are more difficult to classify. It is well to remember that shrinks are formed during solidification. Since all crystalline substances solidify in dendritic formations, the shrinkage of still mushy metal will prevent the interstices of the dendrites from filling. Thus by careful examination it is possible to positively classify a defect as a shrink if dendrites protrude into the cavity. For example, an evaporating dish originally contained a concentrated solution of picric acid in alcohol. As the alcohol evaporated, crystallization began and continued by dendritic formation until only a small amount of solution remained in the bottom of the dish. Since no external feeder was attached to the dish, the existing dendrites drew the remaining dissolved material to them, leaving a hollow spot which bears a remarkable resemblance to an internal shrink cavity.

Since shrink areas usually are the last to solidify, they too are characterized by phosphorous segregation. Pellets such as are evident in gas defects are not formed, and the physical model of the steadite serves to easily distinguish between the two.

Some of the more frequent causes of casting defects have been mentioned, as well as a few of the methods by which the laboratory may be able to properly classify them. It should not be assumed that the detection of the nature of a defect is always a clear-cut problem. Sometimes several things may happen at once to complicate the problem, and a complete follow-through of each operation in the production of the casting may be necessary before any conclusion can be drawn.

The author has had considerable success with a method in which the conditions believed to cause the trouble are exaggerated. If the trouble is aggravated by this means, it is known that the conclusions drawn from the investigation were correct. If no increase in the trouble is evident, the original hypothesis is rejected and a new investigation of the available evidence undertaken.

METALLURGY IN THE FOUNDRY

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THE WRITER IS QUITE AWARE that the technical man, whether metallurgist or chemist, appears to be more or less of a nuisance to the average foundryman. He persistently waves pyrometers and other gadgets of his profession, especially when the foundryman is preoccupied with other matters. He takes what appears to be perfectly good castings and breaks them to see what they are like inside, thereby decreasing production.

He is behind the hand that delves into the molder's or coremaker's sand pile, taking samples of it and later returning to bother him about the moisture content or some other physical constant. The writer also realizes that the molders and coremakers are the basic producers in the foundry but, after all, the technical man has to make a living too, and, apart from his apparent nuisance value, he can be of considerable use to the foundry.

Cooperation Necessary

The metallurgical department of a company is not, in the main, concerned with the actual operation of the foundry itself. It exists for the purpose of maintaining a proper control over the composition and quality of the company's products, and also as a source of information and guidance in such foundry problems as lie within the scope of the department. These services of the metallurgist and his staff can be used to best advantage only when a system of close cooperation exists between the technical staff and those responsible for the operation of the foundry.

There are several good reasons why the use of a system of chemical and physical control can be of advantage. Primarily, it is essential that the base materials purchased, such as virgin metals, composition ingot or scrap materials, be satisfactory in all respects for the intended use. The final products of the foundry's operations will be the results of melting and casting these materials, or various mixtures of them, and these products may not be better, in their chemical and physical properties, than the base materials allow. For this reason it is important that the foundry be assured of the satisfactoriness of its purchased materials, and the metallurgical department, through the medium of chemical and physical examination, can accomplish this.

Material-Product Control

Second, it is not alone sufficient that the materials going into the foundry melting units be checked chemically and physically. The final products themselves should be subjected to the same control measures. The customers' specifications must be met, and the metallurgical department assists the foundry in meeting these requirements. On many occasions situations arise where the metal mixes used by the foundry must be changed or modified, and by making use of a system of laboratory control the foundry superintendent can assure himself that his modifications are yielding the desired results.

Third, the modern foundry must keep abreast of the latest developments in the alloy field. It must be familiar with the properties of the new alloys so that the possibility of using them in the foundry can be determined. Quite often a customer, in placing an order, may specify an alloy with which the foundry has not had previous experience. Here again the metallurgical department comes into its own, for its services are essential where investigations must be made into the chemical, physical and casting properties of new alloys.

Finally, but by no means least in importance, is the value of a metallurgical staff as a service to the customer and, therefore, as a valuable sales point. Apart from the fact that it gives the customer a certain feeling of security to know that his materials are being manufactured under controlled conditions, a technical department is always available for the purpose of assisting the customer in the solution of many of his problems. This service can be of considerable value in cementing good business relationships with the customer.

Physical properties of many of the alloys in common use in the nonferrous foundry are not greatly affected by fairly large deviations from some fixed chemical composition. There are a few alloys, however, where the opposite is true, and comparatively slight changes in the chemical structure can have a serious effect on physical properties.

Controlling Composition

Certain high-strength bronzes provide typical examples of this latter case. In order to obtain the required ductility and strength from some particular one of these high-strength bronze alloys it is important that the chemical composition be held within fairly close limits. In determining the extent of these limits, and in assisting the foundry to maintain the final product within these limits, the metallurgical department plays an important part.

Heat-treatable non-ferrous alloys can be regarded from somewhat the same point of view. Here again the

proper chemical composition is essential if an improvement in the physical properties is to be obtained by heat treatment. The absence of lead is especially important since, with many of these alloys, the presence of lead in amounts exceeding 0.2 per cent may render the alloy unresponsive to heat treatment.

Apart from this question of impurities, physical control, taken in conjunction with chemical examination, is all-important in specifying the heat treatment temperatures required for a particular alloy, since the pattern of heat treatment will vary according to changes in the chemical composition. A technical staff will be able to provide, on the basis of chemical and physical investigations, a fund of information on the temperatures necessary for the heat treatment of a range of compositions in a specific alloy, as well as for a range of physical properties for certain particular compositions in that alloy.

Corrosion Resistance

If there is one thing that annoys the foundry in general, and the molder in particular, even more than having the metallurgist break up good castings, it is to make a fine casting, apparently sound in every respect, ship it to the customer, and in a month or two receive the customer's report that the casting is not standing up for his purpose, namely, resistance to the action of some corrosive liquid.

Frequently the customer will not have mentioned this use when his order was placed. Once the type of corrosion has been specified the metallurgist can advise the foundry as to the proper alloy for the job, basing his decision either on experience or the results of a laboratory investigation.

Again, it quite frequently happens that a customer will order a casting, specifying that it is to be used under conditions where it will be subjected to stress at some elevated temperature. Whether or not a certain alloy will be satisfactory for this purpose can be determined by the results of tests conducted under conditions which duplicate those expected in service. In the event that the alloy fails under test conditions, further investigations may be conducted until the proper alloy for the job is decided upon.

Another situation in which the foundry may turn to the metallurgist for assistance is that in which some difficulty is encountered in the melting or casting of a special metal or alloy. Castings made in pure copper afford an excellent example of this type of situation, since trouble often occurs because of the tendency of this metal to gas during the melting operation. The metallurgist is responsible for advising the foundry on the proper degassing treatment, and for the development of a test to determine whether or not the copper has been adequately degassed before the casting is poured.

Certain of the alloys in common use in the foundry have been found to be adversely affected by the presence of small amounts of certain impurities. Examples of these are leaded bronzes in which silicon or aluminum is harmful, and silicon bronzes in which lead is a dangerous impurity. In a foundry where both of these alloys are being made regularly, it is not always easy to prevent some contamination.

The function of the metallurgical department is twofold in such cases. First, the physical effects of the contaminating substance must be determined. These effects are then plotted against increasing amounts of the impurity in question, so that the maximum limits to which it can be present in a specific case will be known. It then becomes the responsibility of the chemical laboratory to protect the foundry, insofar as possible, by keeping these impurities within the defined limits by means of a careful examination of the base materials used.

Maintaining Sand Properties

One aspect of metallurgy in the foundry will be dealt with briefly. The foundry itself is largely responsible for selecting the types of core and molding sands that are to be used in the shop. Assisting the foundry to maintain the properties of these selections is, however, a duty which often falls upon the metallurgical department.

Control of sand in the foundry may be separated into three distinct divisions. First of all is the control of new sand coming into the plant, to ensure that these sands are in accordance with the specifications under which they were ordered.

Second, the routine checking of the core and molding sands in actual use in the shop, thereby providing the foundry superintendent with information upon which he may base any changes in sand type that he deems necessary.

Finally, there is that division of sand control which concerns itself with checking the characteristics of various core sand mixtures to provide the foundry with a fund of information on their properties and uses. This involves investigations into the results of using different proportions of sand and binder; effects of various types of binders; establishment of baking time and temperature charts, and the correlation of these with physical properties as determined on the different core sands under test.

IBF and IAF Exchange Papers With A.F.A.

THE EXCHANGE of papers between the Institute of British Foundrymen, Institute of Australian Foundrymen and A.F.A. is continuing this year, as it has been found more important than ever during these times of material shortages to maintain this exchange of ideas. The IBF exchange was initiated in 1921 while the Australian exchange was inaugurated in 1946.

The paper from the IBF for the A.F.A. 1948 Philadelphia convention has been prepared by E. Longden, P. R. Jackson & Co., Ltd., Manchester, England. The paper is on "Contraction and Distortion in Ferrous Casting."

Contributed by the Australians is a report on copper lead alloys. This has been prepared by R. W. K. Honeycombe who is a graduate of Melbourne University and has had many of his papers published by the Australian trade press. Mr. Honeycombe is leaving Australia soon to spend three years at Cambridge University, having won a scholarship there.

Vital Foundry Subjects

The A.F.A. exchange papers to these two Institutes are being prepared by R. L. Lee, Grede Foundries, Inc., Milwaukee, and Lester B. Knight, Lester B. Knight & Associates, Chicago. Mr. Lee's paper will be on foundry costs and directed to the IBF, while that of Mr. Knight, which will concern modernization and mechanization, will go to the Australian foundrymen.

EAGAN RECEIVES HONOR AWARD FROM *MATERIALS AND METHODS*

T. E. EAGAN, chief metallurgist, Cooper-Bessemer Corp., Grove City, Pa., and past chairman, A.F.A. Gray Iron Division received an award of honorable mention in this year's *Materials & Methods* Achievement Awards for the use of high strength cast iron for diesel engine crankshafts.

Heretofore, cast crankshafts with large sections have usually been made of gray iron which has been melted in either the electric or air furnace. By exploiting the various processes patented by the Meehanite Metal Corp., and extending the principles on the metallurgy of the acicular gray irons brought out by Flinn and Reese, the metal from which these crankshafts are made is melted in the cupola.

The crankshaft shown is one of a line of cast crankshafts now used in Cooper-Bessemer engines. It is 12½ ft in length, has 9¾ in. diameter pins and journals, and weighs 4200 lb. The tensile strength of the metal is 65,000 to 75,000 psi measured on a test bar cut from the center of a full diameter extension of the crankshaft itself and not from individually cast arbitration bars.

Result of Long Research

This development is the result of eleven years of research and development by the Cooper-Bessemer Corp. and involved an outstanding cooperative effort of design engineers, metallurgists, and foundrymen which resulted in a line of cast iron crankshafts which can be substituted for forged steel crankshafts without change of dimensions. The American Bureau of Shipping has for the first time approved these Cooper-Bessemer shafts for direct propulsion engines.

The cost of producing cast iron crankshafts shows an overall economy of 40 to 50 percent when compared to the usually block forged steel crankshaft. In addition the cast crankshaft has certain physical characteristics which give it engineering advantages over the forged.

A.F.A. Organizes Text Book Committee

TO PLAN and supervise the preparation of new textbooks on foundry practice, the Association has established a new national group known as the Textbook Committee. The committee will select and contract with qualified educators to write the texts, and will appoint subcommittees to assist authors in obtaining necessary technical information and in organizing and reviewing manuscripts.

The new texts will be written by instructors in cooperation with executives and technologists of the foundry industry and will incorporate data on latest theories and techniques of the metals casting field. Three textbooks are planned for the immediate future: a college text; another for trade and technical schools and for apprentice training programs; and a high school text.

It is felt that existing books are out of date and not sufficiently broad in scope, and most of them evidently were written by educators with little industrial experience.

Professor G. J. Barker, chairman, department of mining and metallurgy, University of Wisconsin, Madison, is chairman, textbook committee.

Members include Professor P. E. Kyle, department of metallurgy, Cornell University, Ithaca, N.Y.; C. K. Lush, director of vocational education and industrial arts, Board of Education, Minneapolis; F. C. Moore, director of industrial arts, Board of Education, Cleveland, and P. L. McNamee, assistant superintendent of schools in charge of vocational education, Chicago.

Also Professor Richard Schneidewind, department of chemical and metallurgical engineering, University of Michigan, Ann Arbor; Professor W. H. Ruten, chairman, industrial processes department, Polytechnic Institute of Brooklyn; F. W. Shipley, foundry manager, Caterpillar Tractor Co., Peoria, Ill., and H. F. Taylor, professor of mechanical metallurgy in charge of foundry instruction and research, Massachusetts Institute of Technology, Cambridge.

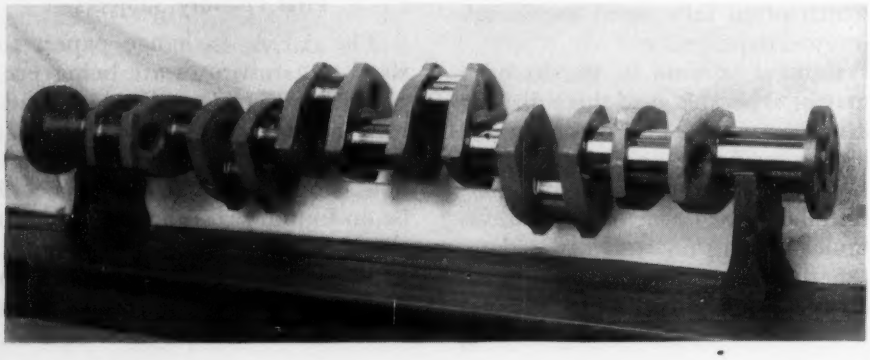
It's Quadruplets

(Continued from Page 27)

Ohio, Canton District, Toledo and Cincinnati. The men appointed as industrial advisors are: Central Ohio Chapter Director J. J. Witenhafer, Columbus Malleable Iron Co., Columbus; Past Cincinnati District Chapter Chairman J. S. Schumacher, Hill & Griffith Co., Cincinnati; Vice-Chairman Canton District Chapter E. H. Taylor, F. E. Myers & Bros. Co., Ashland; Past Toledo Chapter Chairman V. E. Zang, Unitcast Corp., Toledo; and Past Northeastern Ohio Chapter Chairman J. H. Tressler, Hickman, Williams & Co., Cleveland. Mr. Williams and Professor R. P. Schneider, foundry instructor, industrial engineering department, will act as co-faculty advisors.

Below are listed the eighteen members of the Ohio State A.F.A. Student chapter: C. E. Mittec, Wilford Crise, William Griffith, T. S. Dole, Eldon Boner, Joseph Leaverton, Karl Moltreck, Clifford Schutte, Kenneth Smith, Richard Morton, William Dundon, Thomas Pendergast, John Parks, John Onibal, James Hudgins, Gerald Starkey, John Shinn and Robert Brogg.

A high strength cast iron crankshaft 12½ ft long weighing 4200 lb and of 65,000-75,000 psi tensile strength.



Californians Take The Opportunity To Visit Foundry at Mare Island

ON EXHIBIT, and being cast while thousands viewed the operations of the foundry during the recent Navy Day "open house" of the Mare Island Naval Shipyard, Vallejo, Calif., were castings ranging from thumb-size valve parts weighing only a few ounces to battleship propellers of twenty-nine tons. This foundry holds the distinction of being the largest non-ferrous foundry on the Pacific coast. This shop has shipped countless tons of cast metals to other naval yards and contractors throughout the United States, distant bases and to battle damaged ships. The foundry specializes, however, in the production of propellers and torpedo tubes.

Long a pioneer in propeller manufacture, this foundry has originated many of the latest developments in foundry engineering which have been adapted by the Bureau of Ships for general use throughout the service. Recently the Bureau assigned a project calling for the development of radiographically sound castings at Mare Island and a committee has been named to complete the research work in which the foundry is playing a leading role.

Keeping abreast of scientific development in the field of metallurgy with a well-equipped laboratory and experienced technically trained men, the foundry recently installed a high frequency induction furnace for melting monel metal.

In 1920, after being housed for a number of years in separate buildings, the iron and brass foundries were placed under one roof, Building 128. But in 1940, when the shop had geared itself to wartime production, the foundry was provided a spacious, new plant in Building 678.

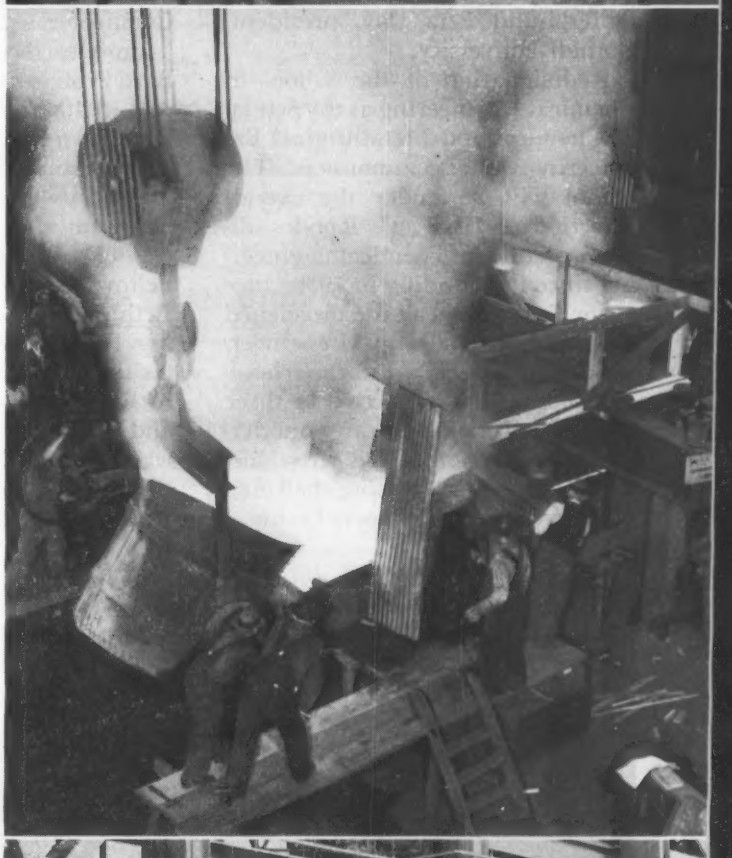
During the following years,, quality and production became the by-words of the foundry. With a force exceeding 600 employees, more than 1,000,000 pounds of castings were shipped monthly with less than three per cent loss—an outstanding record of achievement.

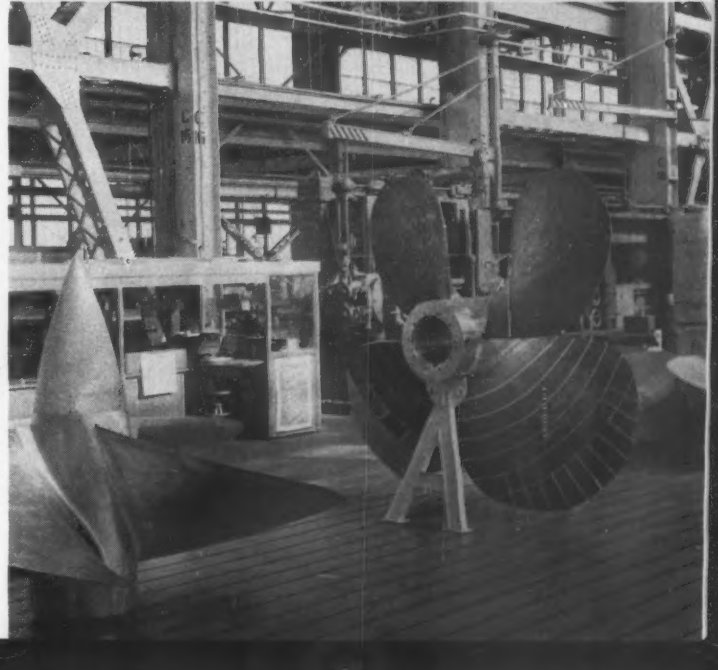
In charge of the shop as master molder is A.F.A. member Joseph Bentley. He came to Mare Island as a leadingman molder in 1915. Appointed acting leadingman in 1935, he advanced as quarterman molder (1939), chief quarterman molder (1942) and in 1944 was made master molder.

Another active A.F.A. member from this naval establishment is George Dalbey. He is metallurgist at Mare Island and is known for his contributions on brass and bronze metallurgy at both A.F.A. chapter and convention sessions.

At a recent meeting of the A.F.A. Northern California chapter, of which Mr. Dalbey is a member, he was principal speaker. He talked on "The Solidification of Metals." In the October AMERICAN FOUNDRYMAN, pp. 35-42, Mr. Dalbey had published his report on "Segregation in Manganese Bronze."

Other A.F.A. members at the Navy Yard are: E. E. Greenwell, leadingman patternmaker; C. V. Nyland, molder; and C. E. Rowe, metallurgical assistant.





Top and center—Pouring propellers for the nation's navy at the Mare Island Naval Shipyard. Bottom—(Starting left)— Finished, semi-finished and rough casting in the machine shop.

CORNELL UNIVERSITY NAMES KYLE AS BARD PROFESSOR

PROFESSOR Peter Edward Kyle became the first holder of the Bard professorship at Cornell University, Ithaca, N.Y., at a dinner November 7 honoring Francis Norwood Bard, donor of a $250,000 fund to endow the professorship. Owner of the Barco Mfg. Co., Chicago, Mr. Bard established the professorship to inspire and develop scientists in the field of metallurgy and foster metallurgical research. Disclosed by Dean S. C. Hollister, college of engineering, who presided at the dinner, the professorship was formally accepted by Edmund Ezra Day, president, Cornell University.

Redesignation of the School of Chemical Engineering as the School of Chemical and Metallurgical Engineering was also announced. The school will be under the overall direction of Dr. F. H. Rhodes, director, school of chemical engineering since its founding in 1938. Professor Kyle will head the broadened program in metallurgical engineering already organized in the school.

Professor Kyle is active in three divisions of the American Foundrymen's Association. He is vice-chairman of the Sand Division, chairman of its Program and Papers Committee, and member of the Committee on Properties of Steel Foundry Sands at Elevated Temperatures. He directs the research project on high temperature property foundry sands, which has been sponsored by A.F.A. at Cornell since 1936, and is assisting in the revision of TESTING AND GRADING OF FOUNDRY SANDS AND CLAYS. He is a member of the Executive Committee of the Educational Division and on the newly formed Textbook Committee. In the Aluminum and Magnesium Division, he serves on the Centrifugal Castings Committee.

Professor Kyle, first holder of the Bard Professorship, returned to Cornell in 1946. Graduate of Cornell, he holds a Master of Science degree in mechanical engineering from Massachusetts Institute of Technology, Cambridge. From 1933 to 1934, he held the James Ward Packard Fellowship at Lehigh University, Bethlehem, Pa., and for the following 12 years was a member of the faculty at M.I.T., where his duties included the courses in materials and metals processing. During the war Professor Kyle served as a consultant on materials and production methods for the British Air Commission and as a research supervisor for the U. S. War Metallurgy Committee.

In addition to the American Foundrymen's Association, he has been actively engaged in committee work with the American Society of Mechanical Engineers, American Welding Society, American Society of Testing Materials and American Society for Engineering Education.

F. N. Bard speaking at a dinner in his honor on the establishment of the Bard professorship of metallurigal engineering, Cornell University. Others at the speaker's table are (left to right) Professor P. E. Kyle, Dean S. C. Hollister and Dr. F. H. Rhodes.

Steel Division Picks Research Project

A STUDY OF the influence of mold conditions on the development of hot tears in steel castings has been selected by the A.F.A. Steel Division as its research project.

Confined to an investigation of factors within the mold itself, the research under exacting laboratory conditions is expected to determine which factors contribute to the development of the defect and to what extent, and to indicate suitable methods for the control of hot tearing in production operations. Also involved in the project is the design of a pattern to serve as a measure of the tear susceptibility of various steels.

Clyde Wyman, metallurgist, Burnside Steel Foundry Co., Chicago, heads the research group which will direct the study.

Among mold factors to be studied in the new A.F.A. project are mold collapsibility, sand grain size, moisture content, hot strength, mold hardness, and binder content.

★ NEW A. F. A. MEMBERS ★

November 15 - December 15 — Detroit continues to lead the membership march this month as we head into the new year. Causing no end of trouble to their leadership, however, were the efforts exerted by the St. Louis, Philadelphia and Wisconsin chapters. They tallied 13, 12 and 12, respectively. Last month 32 chapters sent in 214 membership applications while this month's total of 158 represents 29 A.F.A. chapters.

BIRMINGHAM DISTRICT CHAPTER

A. B. Crawford, Foreman, American Cast Iron Pipe Co., Birmingham.
M. G. Grimes, Molder, American Cast Iron Pipe Co., Birmingham.
Neil Harry Hanson, President, N. Hanson & Co., Birmingham.
Paul G. Jacka, Works Mgr., Southeastern Casting Co., Birmingham.
John P. Washburn, Molder, American Cast Iron Pipe Co., Birmingham.

BRITISH COLUMBIA CHAPTER

William Thomas Beatty, Apprentice, Mainland Foundry Co., Vancouver.
Robert Frederick Bell, Mainland Foundry Co., Vancouver.
Norman Johnson, Molder-Coremaker, Vivian Engine Works, Vancouver.
Robert P. Laird, Sls. Mgr., Aluminum Co. of Canada, Ltd., Vancouver.

CANTON DISTRICT CHAPTER

John Abernathy, Frm., Babcock & Wilcox, Barberton, Ohio.
Robert D. Clay, Sls. Mgr., Tuscora Foundry Sand Co., Canal Fulton, Ohio.
Carl G. Hoffer, Instructor, North Canton High School, East Canton, Ohio.
Alfred A. Mesarchik, Masillon Steel Casting Co., Masillon, Ohio.
Walter J. Pearce, Owner, Custom Built Wood Works, Canton, Ohio.

CENTRAL INDIANA CHAPTER

*Non-Ferrous Foundries Inc., Indianapolis. (N. E. Baker, President)
Geo. Grieswell, Fdry. Frm., International Harvester Co., Richmond.
Charles Thompson, Ass't Frm., Electric Steel Casting Co., Speedway.

CENTRAL MICHIGAN CHAPTER

Dale F. Ball, Frm., Albion Malleable Iron Co., Albion.
Donald Dice, Ass't Purch. Agent, Albion Malleable Iron Co., Albion.
Lewis Koch, Frm., Albion Malleable Iron Co., Albion.
Alex Kolodica, Frm., Albion Malleable Iron Co., Albion.
Bert F. Lambrecht, Gen. Mgr., The Albion Pattern Co., Albion.
Harold Labun, Albion Malleable Iron Co., Albion.
D. Richard McAuliffe, President, Albion Iron & Metal Co., Albion.
Delbert E. Shireley, Frm., Albion Malleable Iron Co., Albion.

CENTRAL NEW YORK CHAPTER

Malcolm S. Burton, Ass't Prof. of Met., Cornell University, Ithaca.
Robert M. Holbert, App. Molder, Sweets Foundry, Inc., Johnson City.
William R. Jones, Gen. Frm., Ingersoll Rand Co., Painted Post.
James Palmer, Fdry. Engr., Ingersoll Rand Co., Painted Post.
Francis H. Troy, Sls. Engr., F. F. Shortsleeve Co., Elmira.

CHESAPEAKE CHAPTER

Arthur F. Prior, Arthur Prior Pattern & Model Works, Baltimore, Md.

CHICAGO CHAPTER

Wilbur H. Doll, Head, Auto., Diesel & Machine Shop Dept., American School, Chicago.
J. H. Hamnett, Chief Met. & Fdry. Supt., Johnson Motors, Chicago.
William Henry Potter, Supvr. Engr., McClure Hadden & Ortman Inc., Chicago.
George H. Starman, Jr., Sls. Engr., Apex Smelting Co., Chicago.
Almer Wandt, Frm., Hansell Elcock & Co., Chicago.

CINCINNATI DISTRICT CHAPTER

R. S. Wahl, Sls. Engr., Federated Metals Div., American Smelting & Refining Co., Cincinnati.
W. P. Waller, Sls. Engr., Federated Metals Div., American Smelting & Refining Co., Cincinnati.

DETROIT CHAPTER

*Dostal Per-Mold Foundry Co., Pontiac, Mich., (Joseph L. Dostal, President)
*Peninsular Grinding Wheel Co., Detroit. (C. E. Price, President)
Richard B. Allen, Engr. Operations Research, Chrysler Engineering, Mt. Clemens, Mich.
Howard J. Barber, Sls., U. S. Reduction Co., Detroit.
George Bieberbach, Michigan Steel Casting Co., Detroit.
Richard G. Caulton, Slsmn., Federated Metals Div., American Smelting & Refining Co., Detroit.
Harold J. Gahan, Continental Div., Wilson Foundry & Machine Co., Pontiac.
Robert W. Gardner, Ford Motor Co., Detroit.
Thaddeus Giszczak, Research Met., American Foundrymen's Association, Detroit.
Mike Gittlen, Sls., Consumers Metal Corp., Detroit.
C. M. Goodrich, Sls. Engr., U. S. Graphite Co., So. Lyon, Mich.
Ralph D. Killian, Jr., Supvr., Ford Motor Co., Dearborn.
Henry A. Laforet, Ford Motor Co., Detroit.
Monroe Messinger, Slsmn., Federated Metals Div., American Smelting & Refining Co., Detroit.
Leonard Paduan, Frm. Conveyor, Central Specialty Div., King-Seeley, Ypsilanti, Mich.

E. CANADA AND NEWFOUNDLAND CHAPTER

J. H. Bertrand, Plant Engr., Canadian Car & Foundry Co. Ltd., Monreal, Que.
W. Bolduc, Owner, LaFonderie Roxton Falls, Roxton Falls, Que.
Robt. F. Ferguson, Mgr., Robert F. Ferguson & Sons, Ottawa, Ont.
Alfred James, Ass't to Prod. Supvr., Canadian Car & Foundry Co. Ltd., Steel Fdry. Div., Longue Pointe, Que.
Carleton Smith, Branch Mgr., The Canada Metal Co. Ltd., Montreal, Que.

METROPOLITAN CHAPTER

J. H. Brindle, Sls. Repr., Electro Metallurgical Sales Corp., Ridgewood, N.J.
Stephen L. Feduska, Taylor-Wharton Iron & Steel Co., Washington, N.J.
W. R. Newell, Jr., Sls. Rep., American Brake Shoe Co., Bronxville, N.Y.
John S. Reno, Sls. & Service Engr., Herman Pneumatic Machine Co., Lyndhurst, N.J.
Leslie T. Schakenbach, Met., Forest Hills, N.Y.
Franz Schumacher, Patt. Supt., The Copper Alloy Fdry. Co., Union, N.J.

MEXICO CITY CHAPTER

*Fundicion de Acero Electrico, The Texiutlan Copper Co. S.A. Mexico, D.F. (C. K. Brunner, Mgr.)
Robert Lozano, Mgr., Fundicion y Taller Anahuac, S.A. N.L. Mexico.

MICHIANA CHAPTER

Dale S. Klinedinst, Frm., Oliver Corp., So. Bend, Ind.
Charles Mainland, Met., Casting Service Corp., LaPorte, Ind.
Edward A. Zatarga, Melting Frm., Oliver Corp., So. Bend, Ind.

NORTHEASTERN OHIO CHAPTER

*Interlake Chemical Corp., Cleveland. (R. G. Booty, Ass't to President)
John Clark Alberts, Osborn Mfg. Co., Cleveland.
Robert E. Daine, Research Met., Aluminum Co. of America, Cleveland.
R. W. Eichenberger, Pur. Dept., Osborn Mfg. Co., Cleveland.
Joseph R. Gilbert, Met., Aluminum Co. of America, Cleveland.
William A Meissner, Jr., Sls. Repr., L. A. Cohn & Bro., Inc., Garfield Heights
Edw. W. Pierie, Frm., The Motor Patterns Co., Cleveland.

NORTHERN CALIFORNIA CHAPTER

Ernest Bosco, Cupola Frm., H. C. Macaulay Foundry Co., Berkeley.
Andrew A. Caridis, Sls. Engr., Natural Gas Equipment Inc., San Francisco.
Peter Frisa, Frm. Maintenance, H. C. Macaulay Foundry Co., Berkeley.
Victor Henderson, Patt. Shop Frm., H. C. Macaulay Foundry Co., Berkeley.
B. W. Knight, Abrasive Engr., Simonds Abrasive Co., San Francisco.
George Rezendes, Frm. Coreroom, H. C. Macaulay Foundry Co., Berkeley.
James W. Rimmer, Slsmn., Columbia Steel Co., San Francisco.
Robert C. Tavalero, Mare Island Naval Shipyard, Vallejo.

NO. ILLINOIS AND SO. WISCONSIN CHAPTER

Charles Ludwig, Molding Frm., Geo. D. Roper Corp., Rockford, Ill.

NORTHWESTERN PENNSYLVANIA CHAPTER

*J. A. Zurn Mfg. Co., Erie. (John H. Schmid, V. Pres. Engr.)
Russell K. Williamson, Erie Malleable Iron Co., Erie.

PHILADELPHIA CHAPTER

*Ace Iron & Metal Co., Camden, N.J. (Jos. G. Gastler, Secretary)
Stanley C. Bentley, Sand Tech. & Radiographer, Crucible Steel Casting Co., Chester, Pa.
Martin W. Caulfield, Sls., National Refractories Co., Philadelphia.
Carter S. Cole, Ass't Tech. Sec., American Society for Testing Materials, Philadelphia.
A. W. Grosvenor, Prof. of Met. Engr., Drexel Institute of Technology, Havertown, Pa.
Francis J. Hyndman, Fdry. Supt., Baccellieri Mfg. Co., Kirkwood, N.J.
Arthur W. Palm, Sls. Repr., Olney Fdry. Div., Link-Belt Co., Johnsville, Pa.
Vernon D. Platt, Mgr., Somerton Quarries, Somerton, Pa.
John M. Schraeder, Time Study Man, Olney Fdry Div., Link-Belt Co., Philadelphia.
Anning H. Smith, Sls. Repr., Barth Smelting Corp., Havertown, Pa.
Kenneth M. Smith, Asst Supt., DeLaval Steam Turbine Co., Trenton, N.J.
Harold S. Weaver, Frm. Patt. Dept., Lancaster Malleable Casting Co., Denver, Pa.

QUAD CITY CHAPTER

Frank A. Komatar, Lab. Supvr. & Chemist, Union Malleable Iron Co., E. Moline, Ill.

ROCHESTER CHAPTER

W. A. Lewis, Expediter, Morgan Machine Co. Inc., Rochester, N.Y.

TIMBERLINE CHAPTER

C. C. Dehn, Dist. Mgr., Metal Goods Corp., Denver, Colo.

ST. LOUIS CHAPTER

Allen L. Eubanks, Frm. Finishing Cleaning, General Steel Castings Corp., Granite City, Ill.

* Company Membership

E. O. Fattman, Sls., General Refractories Co., St. Louis.
G. N. Gwin, Sr., Frm. Core Dept., General Steel Castings Corp., Granite City, Ill.
William H. Hefelfinger, Mfg. Engr., General Steel Castings Corp., Granite City, Ill.
Ralph E. Kalert, Frm. Core Dept. General Steel Castings Corp., Granite City, Ill.
Sam. J. Keebler, Leader-Core-Setter, General Steel Castings Corp., Granite City, Ill.
C. A. Kenyon, Supt., Lewin-Mathes Co., St. Louis.
Wm. J. Long, Frm. Proc. Fdry., General Steel Castings Corp., Granite City, Ill.
W. R. Prewett, Frm. Core Dept., General Steel Castings Corp., Granite City, Ill.
John D. Pierron, Frm. Fdry., General Steel Castings Corp., Granite City, Ill.
Walter V. Rapp, Frm. Core Dept., General Steel Castings Corp., Granite City, Ill.
Otto Schoeber, Frm. Core Dept., General Steel Castings Corp., Granite City, Ill.
Wm. J. Suliburk, Fdry. Supvr., Geo. J. Fritz Foundry & Machine Co., St. Louis.

SOUTHERN CALIFORNIA CHAPTER

Albert W. Broderman, Core-room Frm. Compton Foundry, Compton.
James J. Dwyer, Sls. Repr., Chamberlain Co., Burbank.
John W. Janca, Prod. Mgr., Westlectric Castings, Inc., Los Angeles.
Melvin L. Kern, Ass't Mgr., Fairbanks Morse & Co., Pomona.
Percy L. Mickle, Molding Frm., Westlectric Casting Inc., Los Angeles.
Eugene C. O'Connell, Serv. Engr., Independent Pneumatic Tool Co., Los Angeles.
Joseph G. Rosales, Gen. Supt., Airesearch Mfg. Co., Los Angeles.
Leonard R. Spendlove, Gen. Frm., Compton Foundry, Compton.

TEXAS CHAPTER

Russell Caslin, Mgr., Independent Pneumatic Tool Co., Houston.
Lee M. Killman, Frm., McKinley Iron Works, Ft. Worth.
David L. Kistler, Met., Sheffield Steel Corp. of Texas, Pasadena.
William Maxwell, Fdry. Supt., Bethlehem Supply Co., Corsicana..
Paul N. Renegar, Supt., McKinley Iron Works, Ft. Worth.
James A. Sinclair, Mrg., McArdle Equipment Co., Houston.
Burton W. Wallin, Sls. Engr., McArdle Equipment Co., Houston.

TOLEDO CHAPTER

Bernard J. Beierla, Met., E. W. Bliss Co., Toledo, Ohio.

TWIN CITY CHAPTER

William Gordon, Fdry. Supt., Donovan Inc., St. Paul.
Phillip E. Gustafson, Ass't Fdry. Met., Minneapolis-Moline Power Implement Co., St. Paul.
Albert F. Jennrich, Iron Molder, Aluminum Hoist & Derrick Co., St. Paul.
Paul Kirst, Patternmaker, American Hoist & Derrick Co., St. Paul.

WESTERN MICHIGAN CHAPTER

Robert M. Lang, Appr., Campbell, Wyant & Cannon Fdry. Co., Muskegon.
Gerald Smith, Melting Supvr., Lakey Foundry & Machine Co., Muskegon Heights.
Arthur Wood, Pur. Agent., Standard Foundry Inc., Cadillac.

FUTURE CONVENTIONS AND EXHIBITS

Institute of Scrap Iron & Steel, Inc., Annual Convention, Congress Hotel, Chicago—Jan. 19-20.

Refrigeration Equipment Manufacturers Association; Refrigeration and Air Conditioning Exposition, Cleveland—Jan. 26-29.

American Standards Association, Seminar on standardization work and writing of standard specifications at Engineering Societies Building, New York—Jan. 26-30.

Wisconsin Regional Conference, 11th Meeting, Schroeder Hotel, Milwaukee—Feb. 12-13.

Birmingham Regional Conference, 16th Meeting, Tutwiler Hotel, Birmingham, Ala.—Feb. 12-14.

American Institute of Mechanical Engineers, Annual Meeting, New York—Feb. 15-19.

Society of Automotive Engineers, National Passenger Car Meeting, Detroit—March 3-5.

Northeastern Ohio Chapter Regional Conference, Case Institute of Technology, Cleveland—March 11-12.

American Society of Tool Engineers, 16th Annual Meeting and Tool Exhibition, Cleveland—March 15.

Magnesium Association, 4th Annual Meeting, Pennsylvania Hotel, New York City—March 18-19.

Chicago Technical Societies Council, Chicago Production Show, Stevens Hotel, Chicago—March 18-19.

National Association of Corrosion Engineers, Jefferson Hotel, St. Louis, Mo.—April 5-8.

AMERICAN FOUNDRYMEN'S ASSOCIATION, 52nd Annual Convention and Exhibit, Philadelphia—May 3-7.

American Society for Testing Materials, 51st Annual Meeting, Detroit—June 21-25.

WISCONSIN CHAPTER

Ralph P. Dambrlich, Frm., Mid City Foundry, Milwaukee.
Clarence Fabiszak, Frm., Mid City Foundry Co., Milwaukee.
Stanley Fabiszak, Main. Frm., Mid City Foundry Co., Milwaukee.
Stanley Gradecki, Frm. Core-room, Mid City Foundry Co., Milwaukee.
Thomas G. Gradecki, Frm., Zenith Foundry Co., Milwaukee.
Norbert P. Krafcheck, Per. Mgr., Mid City Foundry Co., Milwaukee.
Walter P. LaMott, Frm., Zenith Foundry Co., Milwaukee.
Valentine Lucas, Pattrn. Frm., Mid City Foundry Co., Milwaukee.
John M. Puhl, Process Engr., Crucible Steel Casting Co., Milwaukee.
Clem E. Salaty, Molding Frm., Mid City Foundry Co., Milwaukee.
Frank E. Schultz, Molding Frm., Mid City Foundry Co., Milwaukee.
James C. Wieland, Ass't Secy. & Treas., Mid City Foundry Co., Milwaukee.

NON-CHAPTER

James M. Barrabee, Massachusetts Institute of Technology, Cambridge.
James H. Bechtold, University of Illinois, Champaign.
Ralph Lawrence Severson, Mfg. Engr., Trafford Fdry., Westinghouse Electric Corp., Pittsburgh, Pa.

Australia

H. V. Johnson, Mgr., Symonds Foundry Pty. Ltd., Sidney.

Brazil

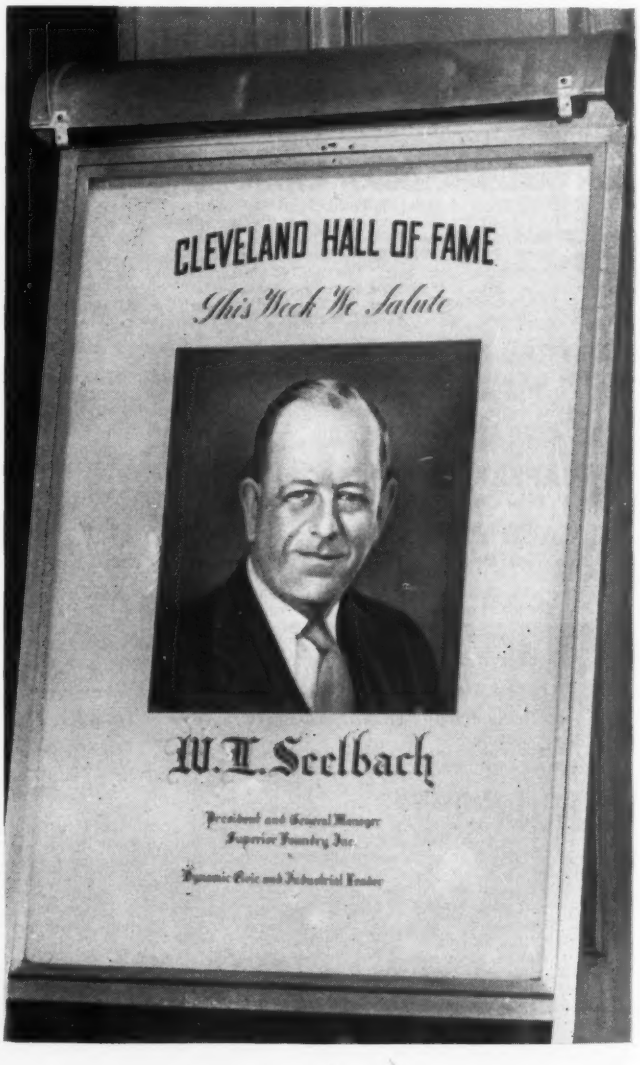
Aldo Bardella, Engr., Bardella S .A. Industries Mecanicas, Sao Paulo.
Institute Technologico Di Rio Grande Da Sul, Porto Alegre, R. G. Da Sul.

England

Edward Longden, Wks. Mgr., P. R. Jackson & Co. Ltd., Manchester.

France

Marcel Ballay, Dr., Tech. Service Mgr., Centre D'Information du Nickel, Paris.



Walter L. Seelbach, president and general manager, Superior Foundry, Inc., Cleveland, was recently saluted as the "Man of the Week" in Cleveland's Hall of Fame. This honor was bestowed upon Mr. Seelbach for his unusual civic and industrial activities.

FOUNDRY PERSONALITIES

W. M. Hamilton, general superintendent, Crane Ltd., Montreal, Que., Canada, has been transferred to the Chattanooga, Tenn., plant, Crane Co. Mr. Hamilton was a Director of the Eastern Canada & Newfoundland chapter.

Mr. Hamilton's position is being assumed by **John D. Walker,** also an A.F.A. member.

The following men were recently elected directors of the Jamestown Malleable Iron Corp., Jamestown, N.Y.: **Oscar A. Lenna, Arthur E. Schobeck, Gustaf A. Lawson, Marvin C. Wilson, Harry A. Lenna, Harry L. Briggs, Carl J. Maim, Fred L. Foster, David Lincoln** and **Reginald A. Lenna.**

Officers elected were: chairman of the board, **Oscar A. Lenna;** president and general manager, **Arthur E. Schobeck;** vice-president, **Gustaf A. Lawson;** secretary and treasurer, **Marvin C. Wilson;** assistant secretary and treasurer, **Vern W. Weekman;** executive committee, **Oscar A. Lenna, A. E. Schobeck** and **Marvin C. Wilson.**

Frank C. Riecks, technical director, Ford Motor Co., Detroit, has taken over the duties of **Joseph Lawry** who has resigned as assistant general plant manager in charge of the foundry, foundry machine shop and motor building. Mr. Lawry has been with the company since 1912.

Robert W. Green, superintendent of the foundry building and a Ford employe since 1922, also has resigned.

Karl H. Kostenbader has been appointed assistant superintendent of the steel foundry, Bethlehem (Pa.) plant, Bethlehem Steel Co. He is a graduate of Lafayette College, Bethlehem, Pa., and received a master's degree from Yale University, New Haven, Conn., in 1926, the year he entered the employe of the steel company.

Louis D. Alpert has been made assistant to the Pacific coast general manager, **John S. Selfridge, Jr.,** superintendent of the San Francisco plant, and **Robert C. Caldwell,** assistant superintendent of the same plant, in important promotions by Federated Metals Div., American Smelting & Refining Co.

Mr. Alpert affiliated with Federated Metals in 1935 and has been a member of the research department of both the Whiting (Ind.) and Perth Amboy (N.J.) plants. He has been superintendent of the San Francisco plant since 1942.

Mr. Selfridge was formerly assistant superintendent of the San Francisco plant until his present promotion.

Mr. Caldwell was general foreman in charge of brass ingot department beginning in 1944, which position he held until his present promotion.

W. S. Kendrick, a 40-year man in the General Electric organization, who has been General Electric X-Ray Corporation's vice-president in charge of sales for 25 years, has joined the president's staff, where he will handle special assignments. While with the parent company, Mr. Kendrick for several years headed the Special Products Department, which sought markets for new inventions developed at the research laboratory in Schenectady.

John H. Smith, who came to the firm recently as assistant to the president, has been named vice-president in charge of the Marketing Division.

W. S. Kendrick

J. H. Smith

E. L. Ramsey

E. L. Ramsey, who retired recently as superintendent of steel production, Wisconsin Steel Co., Chicago, has resumed active work in the steel industry as a technical consultant with Miller & Co., Chicago. His retirement from Wiscinson Steel ended a 25 year tenure with this company. Mr. Ramsey has been a steel man since his first job at Farrell (Pa.) plant in 1901. Following that his service in the industry was: U. S. Steel Corp., 1902; Republic Steel Corp., 1912; Mesta Machine Co., 1917; then Wisconsin Steel.

Arthur P. Hall has been named assistant director of public relations and advertising, Aluminum Co. of America, Pittsburgh, Pa. Mr. Hall has been district sales manager for the aluminum company for the past four years with offices in Washington, D.C. He will be succeeded by **R. A. Learnard,** assistant district sales manager in Washington.

Mr. Hall joined the Aluminum Co. of America in 1929. He became resident manager of the company's New Orleans office in 1932, and was transferred to Washington, D.C. in 1939. In 1943 he was made manager of the Washington district office, and was named an assistant secretary of the company the same year.

Andrew Van Echo, formerly technical service representative and chief inspector, Joslyn Stainless Steel Co., Fort Wayne, Ind., is now metallurgical engineer for Wm. E. Pratt Mfg. Co., Joliet, Ill. Receiving his Bachelor of Science degree in metallurgical engineering from Ohio State University, Columbus, in 1942, he joined the metallurgical department, Carnegie-Illinois Steel Corp., South Works, Chicago. Was associated with the Manhattan Project at the University of Chicago until November, 1945.

L. F. McCaffrey, special engineer for the metal industries, Allis-Chalmers industrial sales department, is now located in the company's Pittsburgh district office.

Prior to joining Allis-Chalmers in 1945, Mr. McCaffrey served as assistant works manager in charge of operations at the Algoma Steel Co., Ontario, Canada. He is well known to the industry, having been employed by Jones & Laughlin Steel Co., Crucible Steel Co., Weirton Steel Co. and other steel concerns.

N. George Belury has been appointed vice-president, Engineered Castings Division, American Brake Shoe Company and **Harry C. Platt** has been named works manager. Both men will be located at division headquarters, Rochester, N.Y.

Mr. Belury, formerly sales manager, has served in various sales capacities since he joined the Brake Shoe Company in 1937. Mr. Platt, formerly division metallurgist, has been with Brake Shoe's metallurgical department since 1942.

Norman L. Deuble has joined the metallurgical engineering staff, Climax Molybdenum Co., New York City. For the past four years he has been with the M. W. Kellogg Co., Jersey City, N.J., in charge of special processes, and of the work in the high temperature laboratory. Mr. Deuble spent two years in the steel and aircraft production divsions of WPB and prior to that time was associated with The Copperweld Steel Co., Warren, Ohio; Republic Steel Corp.; and United Alloy Steel.

C. C. Walker, Boston, has been elected a commercial vice-president, General Electric Company by the board of directors,

(Continued on Page 90)

FOUNDRY FIRM FACTS

Jones & Laughlin Steel Corp., Pittsburgh, Pa., has awarded, to the Rust Engineering Co., Pittsburgh, a contract for the construction of a new $4,500,000 central boiler plant to serve the south side departments of its Pittsburgh works.

One of the important considerations in the building of this huge plant at this time is the corporation's desire to cooperate fully with the Pittsburgh Smoke Control Program.

The Paullin Equipment Co. has been formed in Buffalo, N.Y., to deal in new and rebuilt mechanical and electrical equipment. In addition to reconditioning compressors and vacuum pumps, the firm will act as consulting engineers and manufacturer's agents. Edward M. Paullin, former assistant manager of the compressor division, Worthington Pump & Machinery Corp., is president.

Great Lakes Mfg. Co., Wyandotte, Mich., has changed its name to **Great Lakes Mfg. & Foundry Co.**

Reps Tool Co., Inc., formerly of New York City, is now located in Hartford Conn., 94 Allyn St.

Construction of a new factory to house facilities for the manufacture of Diesel wheel-type tractors and Diesel motor graders and for the final assembly of scrapers, wagons and rippers has been initiated by **Caterpillar Tractor Co.,** Peoria 8, Ill. Of conventional factory construction, the factory will provide approximately 785,000 sq. ft. of manufacturing area. The unit is the latest building being added to the manufacturer's Peoria plant as an integral part of the company's expansion program designed to effect increased production of existing products in the company's line and to facilitate manufacture of additional models now in the development stage.

Allegheny Ludlum Steel Corp. has notified the War Assets Administration that it accepts its counter-proposal for sale to the company of Plancor 99, government-constructed steel plant operated by Allegheny Ludlum during the war in Dunkirk, N. Y. The counter-proposal agreed to sell the plant to Allegheny for $1,500,000 and the company agreed to pay cash. The company will spend more than $500,000 in converting the plant for the production of stainless steel wire.

Transfer of the 57-year old manufacture of fire pots and blow torches from the Detroit area to the **Hoffman Gas & Electric Heater Division,** Louisville, Ky., is near completion. Construction of new buildings and installation of additional processing and material handling equipment involved an outlay of $500,000.

Formation of the **South American Minerals & Merchandise Corp.,** 445 Park Ave., New York, has been made. Herbert Lorenz is president of the concern. The new corporation will represent a number of important South American producers, importers and exporters located in South America.

The Harold F. Howard Co., 1910 Fisher Building, Detroit 2, has been organized by Harold F. Howard, president. They are management consultants.

A federal center of applied mathematics —the **National Applied Mathematics Laboratories,** Washington, D. C.—has been established as a division of the National Bureau of Standards.

Organized to conduct research and provide services in the field of applied mathematics, the new organization is oriented around modern mathematical statistics as applied to the physical and engineering sciences and to the development and use of modern high speed computing. The Applied Mathematics Laboratories include four separate laboratories: the Institute of Numerical Analysis, the Computation Laboratory, the Statistical Engineering Laboratory, and the Machine Development Laboratory.

Rust Furnace Co., Pittsburgh, Pa., is constructing a car-type annealing furnace for the heat treatment of fabricated pipe for Benjamin F. Shaw Co., Wilmington, Del.

The **C. S. Humphrey Co.,** Moline, Ill., is going to erect a $7,000 addition to its foundry at 249 Second St.

In a move which brings together under a single ownership and management two large producers of colloidal graphite products, **Acheson Colloids Corp.,** Port Huron, Mich., American supplier of these products, has purchased its British counterpart. Through its wholly owned subsidiary, Acheson Colloids Ltd., London, England, the American company has bought the entire operating assets of E. G. Acheson, Ltd., which, in spite of the similarity in name, was a completely independent concern.

The Oliver Pump Co. plans to build and equip a pump factory on a company-owned 10-acre site west of Pomona (Calif.) city limits. Among the units under construction will be a foundry and machine shop. The officers and directors are: I. Alvin Oliver, president; William H. De Vaney, vice-president; Weldon A. Stirratt, secretary; Harvey L. Smith, treasurer; and Joseph A. Allard, Jr., Roland B. Sprich and Mack E. Wrights, directors.

Vulcan Iron & Engineering Ltd., Winnipeg, Man., Canada, has acquired and will conduct the business formerly carried on by Vulcan Iron Works, Ltd., Winnipeg. Mr. J. A. Gairdner, Gairdner & Co. Ltd., Toronto, has been appointed Chairman of the Board of Directors. Other officers of the company are: J. D. McDonald, president; John McK. Isbister, general manager; and H. O. Jones, secretary-treasurer.

Fire of undetermined origin destroyed the **Lay Foundry,** Norwich, N. Y., recently. The foundry was owned by Charles Lay. No estimate of damage was given.

The bronze plaque shown below, a memorial to the war dead of Chicago's Hyde Park High School, was poured in the Wagner Brass Foundry Inc., Chicago. It is 88-in. long and 66-in. high and weighs 900 lb. Measuring ¼-in. thick in the center with raised letters, it also has an intricate and delicate outside border. The mold was filled from five crucibles, pouring at five different stations, and each crucible containing 200 lb of molten metal.

CHAPTER OFFICERS

D. D. Baxter
Sterling Wheelbarrow Co.
Rochester, N.Y.
Director
Rochester Chapter

H. J. Bauman
Ebaloy Foundries, Inc.
Rockford, Ill.
Vice-Chairman
N. Illinois & S. Wisconsin Chapter

M. V. Chamberlin
Dow Chemical Co.
Midland, Mich.
Chairman
Saginaw Valley Chapter

C. P. Caldwell
Caldwell Foundry & Machine Co.
Birmingham, Ala.
Director
Birmingham District Chapter

Edw. Laurendeau
Canadian Pattern & Woodworking Co.
Montreal, Que.
Director
E. Canada & Newfoundland Chapter

G. M. Biggert
United Engineering & Fdry. Co.
Canton, Ohio
Director
Canton District Chapter

W. H. Baer
Naval Research Laboratory
Bellevue, Washington, D.C.
Technical Secretary
Chesapeake Chapter

A. G. Raddatz
Lakeshore Machinery & Supply Co.
Muskegon, Mich.
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Western Michigan Chapter

Manuel Goicoechea
Fundiciones De Hierro Y Acero S.A.
San Pedro de los Pinos,
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President
Mexico City Chapter

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Eddystone, Pa.
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Philadelphia Chapter

Ray Fickenworth
C & G Foundry & Pattern Works, Inc.
Indianapolis, Ind.
Director
Central Indiana Chapter

D. H. Lucas
Pittsburgh Metals Purifying Corp.
Chicago, Ill.
Director
Chicago Chapter

★ CHAPTER ACTIVITIES ★

news

Twin City
O. J. Myers
Werner G. Smith Co.
Chapter Reporter

More than 150 members and guests of the Twin City chapter of A.F.A. and ASM attended a joint meeting of the two societies in Minneapolis, on November 20, to listen to a very interesting lecture and discussion by G. Vennerholm, Ford Motor Co., Detroit. Mr. Vennerholm stressed the fact that the engineers of today are used to doing things by convention, especially when concerned with the various casting methods.

Since there is such a freedom of choice in both material and design when castings are used for automotive work, it is the fault of the foundries themselves that still more castings are not used by this industry. The automotive engine designers and engineers have tended to shy away from using castings because of the fear of procuring defective parts. Mr. Vennerholm stated that these concerns are absolutely unfounded if proper design and close foundry control are followed.

The speaker then described in detail the various cast metals used in automotive and tractor engines. In his discussion of the five different types of cast iron used in the engines, he mentioned that these materials were classified according to tensile strength and not by chemical composition.

Among the research projects now being carried out by his company are: (1) the control of moisture in the cupola; (2) the investigation of

Dignitaries and spectators who took part in the A.F.A.-ASM joint meeting held November 20 by the Twin City chapter. Guest speaker G. Vennerholm is the second person from the left in the lower right hand photograph.

new refracting materials; and (3) the use of direct reading immersion thermocouples.

No. Illinois-So. Wisconsin

C. L. Dahlquist
Greenlee Bros. & Co.
Chapter Technical Secretary

On November 11 the Northern Illinois-Southern Wisconsin chapter held National Officers night at the Beloit Country Club, Beloit, Wis. Seventy-five members and guests heard A.F.A. National Vice-President W. B. Wallis, Pittsburgh Lectromelt Furnace Corp., Pittsburgh, Pa., and A.F.A. Secretary Wm. W. Maloney, Chicago, give short talks.

Guest speaker of the evening was G. P. Antonic, Walter Gerlinger, Inc., Milwaukee, who spoke on chemically treated sand.

What is chemically treated sand? The chemical process for the preparation of molding sand is an entirely new conception of the functions of the grains of sand in making molds. It is concerned with the surface of the grain rather than the grain as a whole, both from the standpoints of refractoriness and all the functional properties of a good molding sand.

A working knowledge of the process can be had when just the mechanical aspects, which may or may not be the result of the chemical reaction, are considered. Consideration should first be given to the fact that the process uses a coating on the sand grain for refractory and working properties. With this in mind, the chemical ingredient, for explanatory purposes, can be considered a physical mixture instead of a complex chemical composition which it really is.

We can, therefore, define the chemical in use at the present time as a viscous liquid containing an almost pure carbon resin, solvent, catalyst, an emulsifying agent, and water. This carbon resin can be defined as plastic and is non-thermal setting. It is, however, plasticizable in use by the addition of a solvent.

How is this material used? When you receive the prepared sand in your foundry, the sand will be dry just as ordinary silica sands. You then add a solvent to activate the plastic, add clay or bentonite in the conventional manner, and water to make the sand workable and go ahead with the molding. No sea-coal or pitch is used. Cereal may be used if required for certain jobs.

After each reuse, the sand is rebonded by the addition of clay. Obviously, the coating on the grain next to the casting will be burned off. In addition to that, core sand infilters into the system which is also uncoated and this material must be coated in the mulling cycle preparatory to the next use of the sand. The setting of this additional material is done by the radiant heat given off by the casting at the pouring and the solidification period. The amount of plastic required depends on the weight of the castings and the amount of core infiltration.

(Photo Courtesy John Bing, A. P. Green Fire Brick Co.)

Among those present at the Northern Illinois-Southern Wisconsin meeting on November 11 were (starting left) Chapter Chairman J. T. Clausen, Greenlee Bros. & Co., Rockford, Ill.; G. P. Antonic and A.F.A. Vice-President W. B. Wallis.

Timberline

J. W. Creamer
Western Foundry Co.
Publicity Chairman

Addressing the Timberline chapter, November 18, C. A. Sanders, American Colloid Co., Chicago, remarked that many plants, not being properly equipped in machinery and manpower, were making errors in trying to become skilled in certain synthetic practices before giving attention to the disadvantages as well as the advantages. A man should not be called old-fashioned because he uses naturally bonded sands, as with proper sand control excellent castings can be made with many varieties of sands. He went on to say that by simplifying the foundry operation, many human variables can be overcome.

Western New York

F. L. Weaver
Weaver Materiel Service
Chapter Secretary

A number of guests from the Northwestern Pennsylvania chapter and Niagara Falls, Batavia, Lockport and Attica, N.Y., attended the November 7 Western New York chapter meeting. These additional men aided in swelling the attendance to 100 as they met at the Hotel Touraine, Buffalo. Elliott R. Jones, Lumen Bearing Co., Buffalo, chapter chairman, was the presiding officer and Chapter Vice-Chairman Martin J. O'Brien, Jr., Symington Gould Corp., Depew, acted as technical chairman.

The speaker was D. P. Hepler, consulting engineer, Albert Ramond & Associates, New York City, who presented data on "Direct and Indirect Incentives for Foundries." He described in detail the point system along with several other approved methods. Mr. Hepler stressed particularly, the unilateral and bilateral, pointing out the desirability of a job evaluation committee. The speaker covered the problem of incentives and discussed the importance of a standards de-

National Officers night at the Chicago chapter. The event was held November 3 and in the top photograph are (starting left) A.F.A. National Director John M. Robb, Jr., Hickman, Williams & Co., Philadelphia; Chapter Vice-President C. K. Faunt, Christensen & Olsen Foundry Co., Chicago; A.F.A. National President Max Kuniansky and T. W. Curry, Lynchburg Foundry Co., Lynchburg, Va.; and A.F.A. Secretary Wm. W. Maloney, Chicago. Bottom—Al Schilling and Russell Hardy, Howard Foundry Co.; J. W. Gibson, Herman Pneumatic Machine Co.; J. J. Lee, Delta Oil Products Co.; A. Nelson, Howard Foundry Co.; J. C. Gore, Werner G. Smith Co.; C. V. Babcock, Howard Foundry Co.; and L. W. Anderson, Chicago Foundry Co., all of Chicago, make with the smiles for George Biddle, Illinois Clay Products Co., Chicago chapter reporter.

partment to determine costs and particularly for time study education in the foundry. Mr. Hepler illustrated with blackboard and discussed the importance of securing basic data, using coremaking as an illustration. The problem of piece work study was covered very thoroughly.

Northern California

John Bermingham
E. F. Houghton & Co.
Publicity Chairman

On November 14, at the Engineers Club, San Francisco, a member of the Northern California chapter, G. E. Dalbey, metallurgist, Mare Island Naval Ship Yard, Vallejo, gave a very interesting talk on "The Solidification of Metals."

He explained through the equilibrium diagram the observed differences in the gating and risering of castings that indicate the conditions existing in the feeding of the casting. He told why different alloys having approximately the same total solidification shrinkage will in one case have a concentrated shrinkage or pipe and in the other no apparent shrinkage or pipe. The type of alloy, the form of the crystalline skeleton during solidification, the gas content of the molten alloy and the temperature gradient in the mold are vital factors controlling the quality of the casting.

The solidification temperature range of various alloys was fully covered. Charts covering these alloys clearly explained the so-called mushy range and why crystalline progressive growth during solidification had effect upon metal flow into the mold cavity. Crystalline progressive growth was fully explained by simple sketches on a blackboard to show why the metal flow was affected, thus in many cases being the cause of porosity and having a bearing on the density of the casting.

Cincinnati District

C. H. Fredricks
Cincinnati Milling Machine Co.
Chapter Reporter

Purchasers when ordering their patterns should specify production requirements and pattern accuracy limits. This is what V. J. Sedlon, president, Master Pattern Co., Cleveland, told the Cincinnati District members at the November 10 meeting held at Engineering Society Headquarters, Cincinnati, when he talked on the all important subject "Selecting Pattern Equipment."

Mr. Sedlon pointed out that the breakdown on pattern equipment should be as follows: up to 20 castings a soft wood pattern; up to 200 castings a hard wood pattern; and over 200 castings a metal pattern.

Past A.F.A. Pattern Division Chairman V. J. Sedlon talking pattern problems at Cincinnati.

He stressed the necessity of knowing the number of castings required in order to furnish to the purchaser the best pattern equipment for doing the best overall job for the least expenditure of money.

He also stated that all manufacturers of pattern equipment should

CHAPTER MEETINGS
JANUARY-FEBRUARY

JANUARY 15
CANTON DISTRICT
American Legion Hall
Massillon
PROBLEM NIGHT

OREGON
Heathman Hotel, Portland
J. W. CABLE
Induction Heating Corp.
Induction Core Drying

DETROIT
Rackham Educational Memorial
ROUND TABLE DISCUSSION

JANUARY 16
BIRMINGHAM DISTRICT
Tutwiler Hotel
B. P. MULCAHY
Consultant
Cupola Practice and Coke Quality

NORTHWESTERN PENNSYLVANIA
(Sub-Group)
Sharon, Pa.
C. W. BRIGGS
Steel Founders' Society of America
Foundry Sands

JANUARY 19
QUAD CITY
Hotel Fort Armstrong, Rock Island
H. H. KESSLER
Sorbo-Mat Process Engineers
Gates and Risers

JANUARY 20
EASTERN NEW YORK
Circle Inn, Albany
D. J. REESE
International Nickel Co.
Operating the Cupola with Minimum Pig Iron

BRITISH COLUMBIA
Auditorium Medical & Dental Bldg.
Vancouver, B.C.
P. E. BAER
P. E. Baer Engineering Service
Casting Design

JANUARY 21
TOLEDO
Toledo Yacht Club
N. J. DUNBECK
Eastern Clay Products, Inc.
Chemically Coated Sand

JANUARY 23
TEXAS
Hotel Beaumont, Beaumont
L. P. ROBINSON
Werner G. Smith Co.
Variables in the Core Room, Their Treatment and Cure

CHESAPEAKE
Engineers Club, Baltimore
ROUND TABLE DISCUSSION

WESTERN NEW YORK
Hotel Buffalo, Buffalo
ANNUAL STAG PARTY

TRI-STATE
Mayo Hotel, Tulsa, Okla.
Foundry Safety

JANUARY 26
NORTHWESTERN PENNSYLVANIA
Moose Club, Erie, Pa.
G. P. HALLIWELL
H. Kramer & Co.
Manganese Bronze and Aluminum Bronze

CENTRAL OHIO
Chittenden Hotel, Columbus
R. L. MCILVAINE
National Engineering Co.
Foundry Mechanization

JANUARY 30
ONTARIO
Royal Connaught Hotel, Hamilton
NATIONAL OFFICERS NIGHT
W. B. WALLIS
Pittsburgh Lectromelt Furnace Corp.

FEBRUARY 2
CENTRAL INDIANA
Athenaeum, Indianapolis
H. L. SMITH
American Smelting & Refining Co.
Non-Ferrous Melting Atmospheres
FRED WURSCHER
Semet-Solvay Co.
Duplex Melting Operations
NATIONAL OFFICERS NIGHT

METROPOLITAN
Essex House, Newark, N.J.
ROUND TABLE DISCUSSION

FEBRUARY 3
MICHIANA
South Bend, Ind.
C. R. POWELL
Lehigh Safety Shoe Co.
Understanding and Influencing Human Behavior

FEBRUARY 5
TWIN CITY
Covered Wagon, Minneapolis
Chemically Coated Sand

FEBRUARY 6
WESTERN NEW YORK
Hotel Touraine, Buffalo
T. E. BARLOW
Eastern Clay Products, Inc.
Chemically Coated Molding Sands

FEBRUARY 9
CINCINNATI DISTRICT
Engineering Society Headquarters
E. C. HOENICKE
Eaton Mfg. Co.
Permanent Mold Castings

WESTERN MICHIGAN
Schuler Hotel, Grand Haven
H. N. BOGART
Ford Motor Company
Steel Metallurgy and Foundry Practice
Measurement of Temperature in Molten Steel

FEBRUARY 10
CENTRAL MICHIGAN
Columbia Hotel, Kalamazoo
NATIONAL OFFICERS NIGHT
W. B. Wallis
Pittsburgh Lectromelt Furnace Corp.

ROCHESTER
Seneca Hotel
J. P. SELLAS
Michigan Steel Casting Co.
Precision Castings

N. ILLINOIS & S. WISCONSIN
Faust Hotel, Rockford
LADIES NIGHT

FEBRUARY 11
CHATTANOOGA, TENN.
Patten Hotel
CHAPTER ORGANIZATIONAL MEETING

FEBRUARY 12-13
WISCONSIN
WISCONSIN 11TH REGIONAL CONFERENCE
Schroeder Hotel, Milwaukee

FEBRUARY 12-14
BIRMINGHAM
BIRMINGHAM 16TH REGIONAL CONFERENCE
Tutwiler Hotel, Birmingham, Ala.

FEBRUARY 12
CANTON DISTRICT
Swiss Club, Canton
T. W. CURRY
Lynchburg Foundry Co.
Chemically Bonded Sand and Cores

NORTHEASTERN OHIO
Hotel Carter, Cleveland
R. D. SPEIRS
Wright Aeronautical Corp.
Relationship of Patterns, Foundry and Purchasing

ST. LOUIS DISTRICT
York Hotel
R. L. LEE
General Motors Corp.

FEBRUARY 13
PHILADELPHIA
Engineers Club
WERNER FINSTER
American Chain & Cable Co.
The Value of Simple Controls in the Foundry

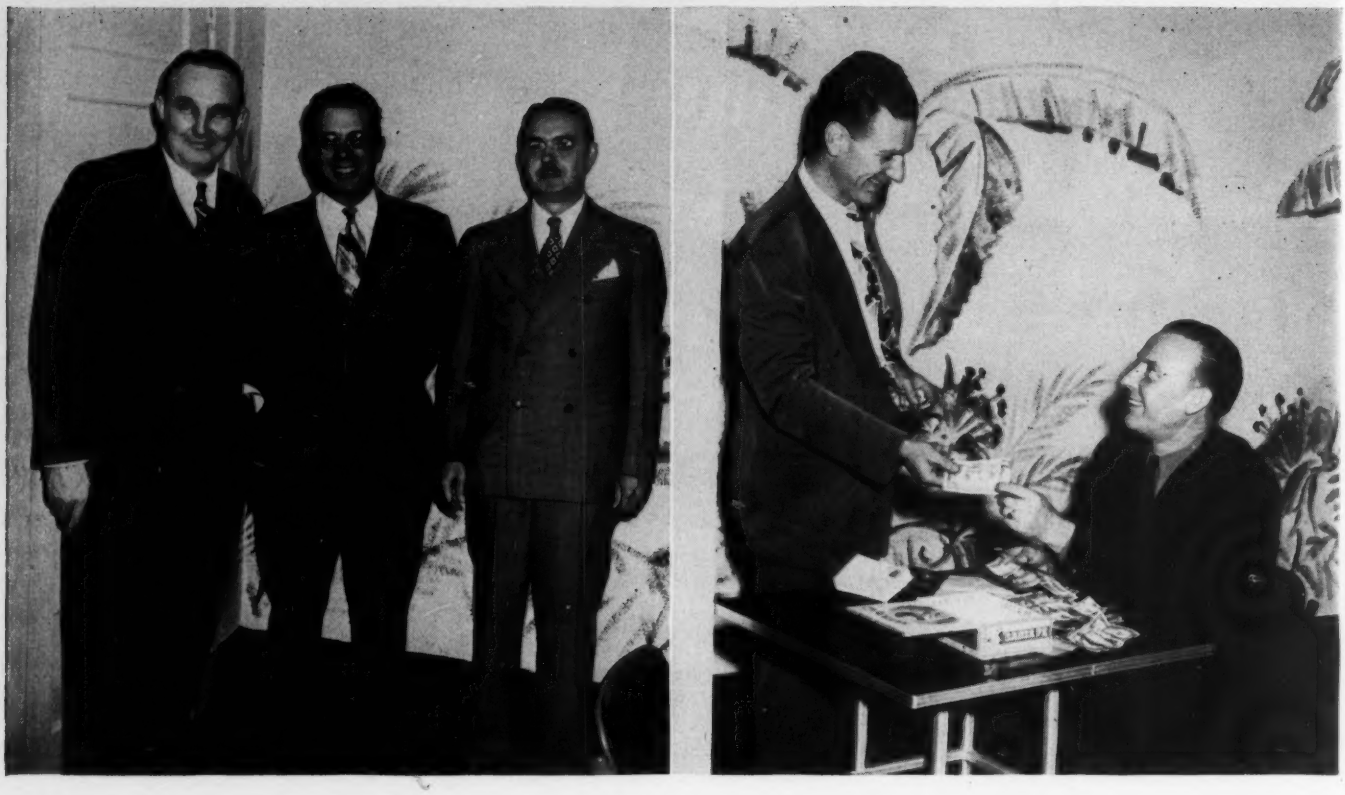
E. CANADA & NEWFOUNDLAND
Mount Royal Hotel, Montreal
E. T. KINDT
Kindt-Collins Co.
Pattern Engineering

NORTHWESTERN PENNSYLVANIA
(Sub-Group)
Sharon, Pa.

CENTRAL NEW YORK
Onondaga Hotel, Syracuse
L. W. EASTWOOD
Battelle Memorial Institute
Unsoundness Caused by Gas Evolution in Non-Ferrous Castings

FEBRUARY 16
QUAD CITY
Hotel Fort Armstrong, Rock Island
L. P. ROBINSON
Werner G. Smith Co.
Let's Stop Guessing in the Core Room

FEBRUARY 23
CENTRAL OHIO
Chittenden Hotel, Columbus
J. H. LANSING
Malleable Founders' Society
Malleable Iron Founding
L. C. TATE
Ford Motor Company
Measurement of Temperature of Molten Metal



Left—H. E. Henderson, H. E. Russill and R. M. Trent at the November Southern California chapter meeting. Mr. Russill is chapter chairman and with Eld Metal Co., Ltd., Los Angeles, and Mr. Trent with Pangborn Corp., Los Angeles. Right—W. W. Stevens, Electro Metallurgical Co., San Francisco, a Northern California visitor, "shells out" to Chapter Treasurer E. D. Shomaker, Kay-Brunner Steel Products Inc., Alhambra.

explain in detail the type of equipment they propose to furnish so that the purchaser can compare equipment and price with a competitor's proposal.

Professor D. C. Williams, Ohio State University, Columbus, and a group of students were guests for dinner and the regular meeting. Their trip also included a visit to the Lunkenheimer Co. and Cincinnati Milling Machine Co.

Chesapeake

J. H. Schaum
National Bureau of Standards
Chapter Reporter

S. W. Brinson, master molder, Norfolk Navy Yard, Portsmouth, Va., was the principal speaker at the November meeting of the Chesapeake chapter held at the Engineers Club, Baltimore. Drawing from his large reserve of past experience, Mr. Brinson talked on chills and chaplets. He described and illustrated many of the castings improved by proper size of chills and chaplets. Chills aid directional solidification, and permit casting of sound sections which otherwise would have been impossible to feed. The speaker advised the use of heavy chaplets on top of cores to resist the large floating forces of the molten metal.

Texas

W. H. Lyne
Hughes Tool Co.
Publicity Chairman

Fifty members and guests of the Texas chapter met in Houston, November 21, at the Texas State Hotel. Ralph Hassett, pattern shop superintendent, Texas Foundries, Inc., Lufkin, gave a short talk on "Core Blowing." He pointed out the advantage of this method of making cores with its uniformity of cores and increased core box life. The preparation of core boxes for blowing operations requires machined parting surfaces, and strategic location of vents and blow holes. The size, as well as the location of these latter elements, along with the type of sand mix and quality of the sand binders, control the direction of flow and the efficiency of packing the sand in the box.

Mr. Hassett mentioned the following "don'ts" in connection with core blowing operations: (1) Don't use a thin section core box that might break or blow-up; (2) Don't attempt to over load the clamping capacity or the sand capacity of the core blower; and (3) Don't use a core box with a poor jacket at flu parting.

The talk was illustrated with sample coreboxes and cores, and showing both desirable and undesirable practices.

Following the question and answer period, the meeting divided into three groups; namely, steel, gray iron and non-ferrous. Each of these groups had individual round table discussions in their respective fields and the discussions were led by the following group leaders: steel, Eugene Silver, Texas Electric Steel Casting Co., Houston; P. B. Croom, Houston Pattern Works; and Farrell Huber, Able Supply Co., Inc., Houston; gray iron, C. R. McGrail, Texaloy Foundry Co., San Antonio; A. H. Stenzel, Stenzel Pattern Works, Houston; and Newall Royall, Royall Firebrick & Supply Co., Houston; non-ferrous, J. C. Garrott, Garrott Brass & Machine Co., Inc., Houston; T. W. Russell, Service Pattern & Model Works,

Houston; H. W. Creeger, Jr., Electro Refractories & Alloys Corp., Houston.

Philadelphia

E. C. Troy
Dodge Steel Co.
Chapter Chairman

The Philadelphia chapter met December 12 at the Engineers Club, Philadelphia. The meeting was well attended as the subject was "Gating and Risering."

F. G. Sefing, International Nickel Co., New York, was the principal speaker. He asked a panel of experts—C. A. Robeck, Gibson & Kirk Co., Baltimore, representing bronze and aluminum; A. Shaw, Olney Foundry Div., Link-Belt Co., Philadelphia, representing cast iron; and E. A. Zeeb, Dodge Steel Co., Philadelphia, representing steel—to stump him with questions.

(Photo Courtesy John Bing, A. P. Green Fire Brick Co.)

J. Martin Klotsche, president, State Teachers College, Milwaukee, (center) was the principal speaker at the November 14 meeting of the Wisconsin chapter. His subject was "One World—Fact or Fiction." Wisconsin chapter general program chairman W. W. Edens, Badger Brass & Aluminum Foundry Co., Milwaukee (left) and Chapter President R. J. Anderson, Belle City Malleable Iron Co., Racine, round out the trio.

Wisconsin

John Bing
A. P. Green Fire Brick Co.
Chapter Reporter

Deviating from the regular technical type of chapter meeting during November, the Wisconsin chapter had J. Martin Klotsche, president, State Teachers College, Milwaukee, for its speaker. Mr. Klotsche's topic was "One World—Fact or Fiction."

"There is very little likelihood that we will see an immediate reconciliation with the Soviet Union," he said. Going on from there he related that what we are likely to see is two countries in open antagonism to each other, one dominated by the United States and one by the Soviet Union. He urged us to use our financial resources to aid in the economic recovery of Europe and to support more vigorously than we have in the past the United Nations organization.

Philadelphia

J. L. Furey
Swan-Finch Oil Corp.
Publicity Chairman

Subject for discussion by J. A. Gitzen, Delta Oil Products Co., Milwaukee, at the meeting of the Philadelphia chapter on November 14 in the Engineers Club was "Cores." His very interesting and enlightening talk covered all phases of core making in the iron, steel and nonferrous industry. The technical

More than 1000 foundrymen attended the Christmas party of the Northeastern Ohio chapter held December 11 at the Hotel Carter, Cleveland.

(Photos Courtesy S. N. Farmer, Sand Products Corp.)

As if you could not tell, the honored guests at this dinner party are the ladies. The occasion—Eastern Canada & Newfoundland chapter's annual ladies night party.

chairman was R. M. Anson, metallurgist, Crucible Steel Castings Co., Landsdowne, Pa.

Timberline

C. E. Stull
Manufacturers Foundry Corp.
Chapter Secretary

The highlight of the October 28 meeting of the Timberline chapter, held at Cunningham's Restaurant, Denver, was an interesting address delivered by F. G. Steinebach, Penton Publishing Co., Cleveland. The topic chosen by Mr. Steinebach was "Trends in the Foundry Industry."

A committee has been appointed by Chapter Chairman J. L. Higson, Western Foundry, Denver, for the restoration of Colorado's first foundry at Central City.

Northeastern Ohio

Edwin Bremer
Pat Dwyer
R. H. Herrmann
Penton Publishing Co.
Chapter Reporters

Featuring round table discussions by the gray iron, non-ferrous, malleable and steel groups, and a speaker followed by a discussion period at the patternmaking session, Northeastern Ohio chapter had one of its

Dunkirk, N.Y., was the scene for a recent regional meeting of the Northwestern Pennsylvania chapter. (Left) Men responsible for the meeting (left to right) E. M. Strick, J. M. Morrison, Chapter Vice-Chairman J. S. Hornstein, Meadville Malleable Iron Co., Meadville; guest speaker L. P. Robinson; Chapter Chairman J. W. Clarke; and Chapter Secretary H. L. Gebhardt, United Oil Mfg. Co., Erie. Right—Speaker Robinson elaborating on a salient point of his discussion.

best meetings of the year November 13 at the Cleveland Club, Cleveland.

At the patternmakers' session, O. L. Ducharme, Kindt-Collins Co., Cleveland, spoke before a group of about 65 members and guests on the subject, "Pattern Shop Cost Accounting." V. J. Sedlon, Master Pattern Co., Cleveland, was chairman of the meeting.

Mr. Ducharme stated that the economic success and the ability to quote accurate prices with no guessing depend on a complete and thorough knowledge of costs. An incomplete financial statement leads to muddled thinking and muddled actions on the part of management, and furthermore it puts the patternshop accountant in a bad light, he added.

Four factors which Mr. Ducharme listed as important in figuring costs are: Material costs, direct labor costs, factory overhead, and selling and administrative expenses. In calculating prices, two additional factors must be considered also. They are production delay times and the percentage of efficiency existing in the plant.

With Arthur Tumpach, Ferro Machine & Foundry Co., Cleveland, in the chair, and with Edwin J. Lally, Jr., Forest City Foundries Co., Cleveland, leading the discussion, the entire gray iron session was devoted to cupola operation and maintenance. Commencing with the proper method of chipping the lining after a heat, Mr. Lally described several types of patching materials and the method of application. For an improved type spout he instanced a U-shaped tile now available, easily installed and superior in every way to the usual brick and mud lined spout.

Lighting Coke

He then continued with a description of the sand bed and cited several methods for lighting the bed coke. Personally he favored the use of a gas torch inserted at four points through shell and lining at the level of the sand bed. Pieces of 4-in. pipe laid on the sand bed and pulled out after the coke is placed, are pulled out through the four openings, to leave small tunnels under the coke for penetration of the gas flames. The holes, of course, are plugged after the coke is ignited.

About 40 members attended the session devoted to a discussion of sand defects in malleable and steel castings. Chairman of the meeting was T. D. West, West Steel Casting Co., Cleveland, and J. E. Dvorak, Eberhard Mfg. Div., Eastern Malleable Iron Co., Cleveland, was discussion leader. Beginning with blows, Mr. Dvorak pointed out that they are caused by sand being too fine, moisture too high, and improper venting. Remedies are to increase grain size of sand, reduce moisture content, and improve venting. In the case of drops, usually caused by low green strength or low mold hardness, the remedies are to increase bond or ram harder. Other sand defects with their causes and remedies were discussed, including scabs, buckles and rat tails, metal penetration, cuts and washes, rough surfaces, veining, etc.

Non-Ferrous Defects

Gas and inclusions was the topic at the meeting of the nonferrous group under the direction of Walter Sicha, Aluminum Co. of America, Cleveland, and Edward J. Vargo, Wellman Bronze & Aluminum Co., Cleveland. Over 30 members were present and a lively period ensued. Consensus was that the principal source of gas in aluminum alloys is in the melting operation, and every precaution should be exerted to hold it to a minimum. Raw material such as ingot and scrap should be dry before being placed in the smelting unit. Furnace atmosphere should be such that no unburnt gases are present, and the melting temperature should be maintained as low as possible. Also the molten metal should be removed from the furnace as soon as it reaches the desired pouring temperature.

Birmingham

J. P. McClendon
Stockham Pipe Fittings Co.
Publicity Chairman

According to C. O. Bartlett, vice-president and director of sales, C. O. Bartlett & Snow Co., Cleveland, more and more foundries are daily being mechanized or modernized. Partial or complete mechanization offers one method by which working conditions can be greatly improved and productivity maintained at an increased rate without changes in rate of pay. More uniformity in casting quality and lower scrap losses

(Continued on Page 82)

C. K. Donoho (left) introducing guest speaker C. O. Bartlett to the Birmingham District chapter.

★ JANUARY WHO'S WHO ★

J. W. Moore

James W. Moore is co-author with J. W. MacKay of an article in this issue on centrifugal casting . . . Mr. Moore was born in Hickory, North Carolina . . . He obtained a Bachelor of Science degree in 1909 and an electrical engineering degree in 1915 from Alabama Polytechnic Institute, Auburn . . . Started his engineering career with Continental Gin Co., Birmingham, as a draftsman (1909-10) . . . From 1910-15 was an engineer with Birmingham Railway Light & Power Co. . . . For one year (1915-16) was associated with United Gas & Electric Engineering Corp., New Orleans, La., as an electrical engineer . . . Began his 32 year affiliation with American Cast Iron Pipe Co., Birmingham, in 1916 as an engineer . . . In 1917, he was appointed chief engineer . . . From 1925-28, he served as works manager and in 1928 he was named manager, research and engineering sales . . . Retained that title until 1940 when he was appointed a member of the president's staff . . . Has written extensively for the trade press in relation to centrifugal castings . . . Has written a book titled *Business of Living* . . . Member of numerous societies including A. F. A., ASME, ASM, Steel Founders' Society, Alloy Casting Institute, American Gas Association, American Petroleum Institute and National Association of Sales Executives.

J. O. Vadeboncoeur

Twenty-nine year old James O. Vadeboncoeur was born in Detroit . . . A graduate of the General Motors Institute, he is also taking foundry and metallurgical courses at Wayne University, Detroit . . . In 1936 he joined Pontiac Motor Division, General Motors Corp., Pontiac, Mich., as clerk . . . The following year (1937) he was a toolmaker apprentice . . . Appointed a student engineer in 1939 . . . A metallurgical shop contact man in 1942, the following year he was made a research metallurgist . . . In 1946 he was assistant chief chemist and at present he is sand control foreman . . . Has written for ASM on tellurium base corewashes . . . A member of the A.F.A., ASME and ASM.

J. G. Dick

Winner of the second prize in the Eastern Canada & Newfoundland chapter's essay contest, James G. Dick's paper is published in this issue . . . Born in Perth, Scotland, twenty-seven years ago . . . Education: Bachelor of Science degree from St. George Williams College, 1947 . . . Has been associated with Canadian Bronze Co. Ltd., Montreal, since 1937 . . . Began as a laboratory assistant and in 1939 was appointed assistant chemist . . . Two years later (1941) was made chief chemist and at present is chief chemist and metallurgist . . . A member of A. F. A., he also holds membership in ASTM.

R. E. Fisher, Jr.

One of the youngest contributors to AMERICAN FOUNDRYMAN, twenty-two year old Raymond E. Fisher, Jr., has a keen knowledge of the foundry industry . . . Reared in Pittsburgh, Pa., he attended military school, then Vanderbilt University, Nashville, Tenn., and Carnegie Institute of Technology, Pittsburgh . . . His education was interrupted when he entered the service of his country as a combat engineer . . . Associated with Bonney-Floyd Co., Columbus, Ohio, he has been a molder, heat treater, service engineer and foundry engineer . . . During 1947 he spent four months visiting British and European foundries . . . Has talked before technical groups on European foundry, molding and melting practice . . . Member of A. F. A., American Welding Society, Institute of Metals (British) and Steel Founders Society.

J. H. Lansing

Following graduation from Williams College, Williamstown, Mass., active overseas service in World War I, and a course at the University of Toulouse, Mr. Lansing entered the malleable iron industry in 1919 at the Troy, N.Y. plant, Eastern Malleable Iron Co. . . . Shortly thereafter he spent several months in study of metallurgy under the late Prof. Enrique Touceda . . . In 1924, the author became metallurgist, Lakeside Malleable Castings Co., Racine, Wis. . . . Resigning later, he was appointed field assistant to the consulting engineer, American Malleable Castings Association . . . Associated with Danville Malleable Iron Co., Danville, Ill., for seven years, he held the positions of general superintendent and works manager . . . Later he was named general manager, Grand Rapids Malleable Iron Works, Grand Rapids, Mich. . . . He assumed his relationship with the Malleable Founders' Society, Cleveland, in 1936 when he took on the duties of shop practice engineer . . . Four years later he took over additional duties as shop practice and development engineer . . . Assumed his present position as consulting engineer when the late Prof. Touceda passed away a few years ago . . . Is extremely active in the A.F.A. Malleable Division being a member or chairman of a number of its subcommittees . . . Holds membership in A.F.A.

A. W. Winston

Birthplace of A. W. Winston, co-author of article with M. E. Brooks which is published herein, was Saginaw, Mich. . . . Attended and graduated from Michigan State College, East Lansing, with a Bachelor of Science degree in chemical engineering (1920) . . . Upon completing college became affiliated with the Dow Chemical Co., Midland, Mich. . . . From 1920-26 he was associated with the chemical engineering and research and production departments . . . Joining the magnesium division

in 1926 he has done all phases of research, production and quality control work . . . He is currently doing general administrative duties . . . Has had a considerable number of articles, reports and papers published over the past 20 years of his 27 year affiliation with Dow Chemical . . . Technical papers have dealt with the fabrication and application of magnesium alloys, including foundry practice, extrusion, rolling and other means of metal shaping . . . ASME, ASM and SAE are organizations in which he holds memberships.

J. W. MacKay

The application of the centrifugal casting process to casting ferrous and non-ferrous products is being discussed by foundrymen today . . . In this issue two men, J. W. MacKay and J. W. Moore, from American Cast Iron Pipe Co., Birmingham, Ala., shed new light on this all-important subject . . . Mr. MacKay hails from Asheville, North Carolina . . . Holds Bachelor of Science degrees in civil and mechanical engineering from the University of Alabama, University . . . He also attended University of North Carolina, Chapel Hill . . . From 1934-36, Mr. MacKay was an instructor at the University of Alabama . . . Joined American Cast Iron Pipe Company in 1936 as mechanical engineer . . . In 1943 he became a sales engineer and holds that position at the present time . . . Taught night classes at the Birmingham center, University of Alabama, from 1941-46 . . .Member of ASM, Steel Founders' Society and Engineers Club of Birmingham.

M. E. Brooks

Magnesium contributors, A. W. Winston and M. E. Brooks, need little introduction to members of the A. F. A. . . . Their findings have been published in a number of A. F. A. TRANSACTIONS . . . Mr. Brooks was born in Eaton County, Michigan . . . Received his Bachelor of Science and Master of Science degrees (1925 and 1928, respectively) from Michigan State College, East Lansing, and Pennsylvania State College, State College, Pa., respectively . . . Became associated with Dow Chemical Co., Midland, Mich., in 1920 and was a laboratory worker . . . At present he is Vice-Chairman, A. F. A. Aluminum and Magnesium Division . . . He is a past Director of the Detroit chapter and takes part in the workings of the Saginaw Valley chapter . . . A.F.A. member.

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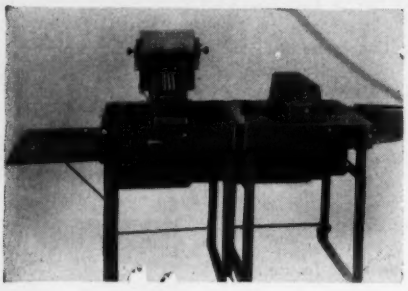
NEW FOUNDRY PRODUCTS



Check Writer

The Todd Co., Rochester, N.Y., is delivering a check writer and signer. Performing six operations in a single process —imprinting, protecting, adding, listing, counting and signing—this machine will process as high as 2500 checks in one operator-hour.

Air Valve

Flex-rite Valve & Mfg., 118 So. Cheyenne. Tulsa, Okla., has developed a blow valve that allows the operator to use just as little or as much air pressure as the job requires. The operator has control over the compressed air stream with the easy-flexing control lever. Flexibility of the unit, either straight or angle nozzle, and the easy flexing lever make it possible for the operator to direct the air stream to the exact spot it is needed without moving into awkward positions.

Cutting Torch

Air Reduction Sales Co., 60 East 42nd St., New York 17, is manufacturing a series 9000 cutting torch with monel head and stainless steel tubes. Monel head gives long service and stainless steel tubes give rigidity and heat resistance; the stainless steel lever and ribbed handle have been designed to afford ease of operation. With this series a total of 22 interchangeable cutting tips are available. Torch is 21-in. long and weighs a trifle over 3 lb. Supplied with 75° or a 90° head but straight heads are available.

Synchronous Motors

General Electric Co., Schenectady, N.Y., is building special 300-hp, 240-rpm inert-gas-filled synchronous motors for use in an inflammable atmosphere. The enclosure has built-in coolers and a sealed chamber which is filled with a non-combustible gas. The gas is under sufficient pressure so that any leakage will be outward and no air or inflammable gas will get into the motor. By removing only one access cover, the field leads, stator leads, terminal boards and bridge resistors for the temperature relay are all within easy reach. The inert gas follows unrestricted flow lines in the cooler, which is located over the motor, to give efficient heat transfer.

Yield Strength Determinator

Aluminum Research Institute, 111 West Washington, Chicago 2, has available a slide-rule type of calculator developed by the Case School of Applied Science which speeds up the yield strength determinations of aluminum and other alloys, which usually requires two operators and considerable time in the plotting of stress-strain curves. The calculator gives tables and instructions for rapid yield strength determination of aluminum alloys, brass, copper, carbon and low alloy steels. Printed on stout varnished stock, it measures 8-in. x 10-in., and is thus convenient for use and for filing. Price is one dollar, postpaid.

Solder

All-State Welding Alloys Co., Inc., 96 West Post Road, White Plains, N.Y., announces a new cast iron solder rod for repairing cracks on cast iron. Rod produces corrosion-resistant welds and can be used on cast iron which must be water-tight and pressure-tight up to 1,000 lb. per sq. in. Also used for sealing and filling cracks and blowholes and for building up where strength is not required. Melts at low temperature and tins easily and rapidly.

Lathe

The Sheldon Machine Co., Inc., 4528 N. Knox Ave., Chicago 41, announce the "S-56" with "zero precision" tapered roller bearings. Headstock has been redesigned, eliminating bearing caps and changing to a larger and solid housing. Equipped with 11¼-in. swing, 1-in. collect capacity. Mounted on a heavy, well ribbed metal cabinet that houses a 4-speed V-belt underneath drive, with double V-belts to spindle. The bed is 56-in. long and has 35-in. between centers.

Work Gloves

Riegel Textile Corp., 342 Madison Ave., New York, announce a "super canton" work glove that is soft and flexible and has a non-slip surface that facilitates gripping and increases protection.

Ear Defenders

Mine Safety Appliances Co., Braddock, Thomas & Meade Sts., Pittsburgh 8, Pa., has designed an ear defender that provides a simple means of excluding excessive noise while permitting speech and warning signals to be heard. The defender is essentially a tapered tube molded from a soft, non-toxic, elastomeric material with an inner septum for filtering harmful noises. A soft, resilient flange surrounding the defender's inner end provides comfortable fit and complete closure of the ear canal. An outer flange, shaped to conform to the lobe of the ear, prevents the defender from entering the ear too far.

Pulley

Eriez Mfg. Co., Erie, Pa., has developed a self-energized magnetic pulley requiring no electric current to generate a magnetic field. These pulleys are being used in conjunction with foundry mold shake-out machines. The pulley removes iron fins, particles and gaggers from the sand as it is elevated over the shakeout screen to be conditioned for reuse. Pulley separates ferrous and non-ferrous borings and turnings and since no wiring is required, portable magnetic separation can be made at several points in a plant with the same unit. Powered by magnets, the pulley has, in many cases, been installed in locations which precluded the use of electrically powered magnetic separators due to severe temperature changes or unusual operating conditions.

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Rough grinding to remove surface imperfections from large steel castings with a Fox Swing Frame Grinder operating at 9,500 surface feet per minute. This is a production grinding operation requiring heavy, fast stock removal. For maximum production at low cost, long efficient wheel life is essential.

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Borolon resinoid bonded A126-S7-B1, size 24" x 3" x 12" with Red Streak Flanges. Embedded into sides around center hole and lining a portion of it, these patented flanges give better spindle fit (steel against steel); truer running; better balance; longer life. With no abrasive wear on machine parts, grinder maintenance is less.

where to get it

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CHAPTER ACTIVITIES

(Continued from Page 77)

will result from improvements in sand conditioning, from pouring of hotter metal, and from increased orderliness that will prevail throughout the foundry. Management and workers alike now recognize the intrinsic value in mechanization as that of labor serving, not just labor saving.

A so-called mechanized loop consists essentially of a line of molding machines, mold conveyors, shakeouts; a conveyor system for returning, screening and storing shakeout sand; mullers, and a conveyor system for distributing prepared sand to molder's overhead hoppers. Such loops are never identical in any two foundries and a final layout is agreed upon only after many compromises. The ideal foundry has yet to be designed or built, according to Mr. Bartlett.

Mechanization starts with mold making facilities. Flask sizes and molding machine production rates, establish the sizes and capacities of all other units.

High-speed molders may be considered as machine operators rather than craftsmen, but as their working conditions improve with clean floors, good lighting, fresh air and ample working space, and as their auxiliary equipment is improved through careful study and coordination their production will increase.

The use of car-type mold conveyor localizes and speeds up pouring, centralizes the cooling and shakeout zones, and simplifies ventilation.

Mr. Bartlett augmented his very interesting and descriptive talk with slide films to illustrate the various types of equipment mentioned.

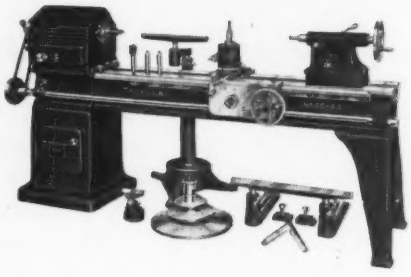
C. K. Donoho, American Cast Iron Pipe Co., Birmingham, chapter program vice-chairman, introduced the speaker at the technical session which was attended by approximately 110 foundrymen and friends.

Southern California
R. R. Haley
Advance Aluminum & Brass Co.
Chapter Reporter

"All there is to any sand is water, clay and silica grains, yet the kinds and proper proportion of these ingredients can differ in ten thousand

(Continued on Page 86)

"OLIVER"
WOOD TURNING
LATHE



for pattern makers

This fast, accurate "Oliver" Wood Turning Lathe features a new principle. The stationary plate carries permanently contact plugs which are fastened to all the motor wires. All power is shut off from the controller while the handwheel locates the sliding plate at any one of the four speeds desired. Made in three sizes to swing 16, 20 and 24 inches. *Ask for Bulletin No 25.*

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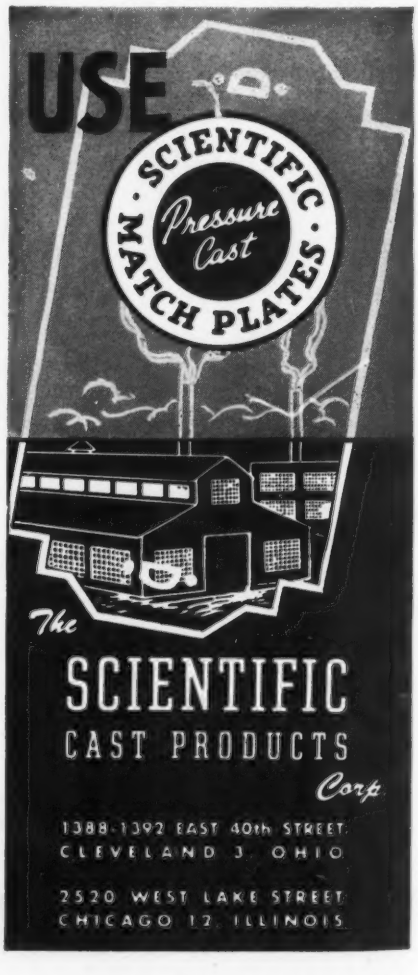

3 ***What is one of the causes of the wormy surface sometimes found in the vicinity of the gate?***

(a) Coarse sand
(b) Low pouring temperature
(c) Inadequate gating
(d) Poor pouring practice

4 ***At approximately what temperature is solution treating of aluminum alloys conducted?***

(a) 300°F
(b) 975°F
(c) 212°F
(d) 1220°F

5 ***What percentage of lead is soluble in solid copper?***

(a) 100%
(b) 2.6%
(c) Practically insoluble
(d) 31.8%

6 ***What percentage of nickel is soluble in solid copper?***

(a) 100%
(b) 32%
(c) Practically insoluble
(d) 50%

7 ***Which alloy has the best corrosion resistance to sea water and brine?***

(a) 88% Cu 8% Sn 4% Zn
(b) Manganese Bronze
(c) 85/5/5/5
(d) Yellow Brass

8 ***Which of the following is most likely to cause a mis-run?***

(a) Cold metal
(b) Ramming too heavy
(c) Gassed metal
(d) Improper sand conditions

9 ***At approximately what temperature is artificial aging of aluminum alloys conducted?***

(a) 300°F
(b) 975°F
(c) 212°F
(d) 1220°F

10 ***What is the melting point of copper?***

(a) 1821°F
(b) 1932°F
(c) 2162°F
(d) 1981°F

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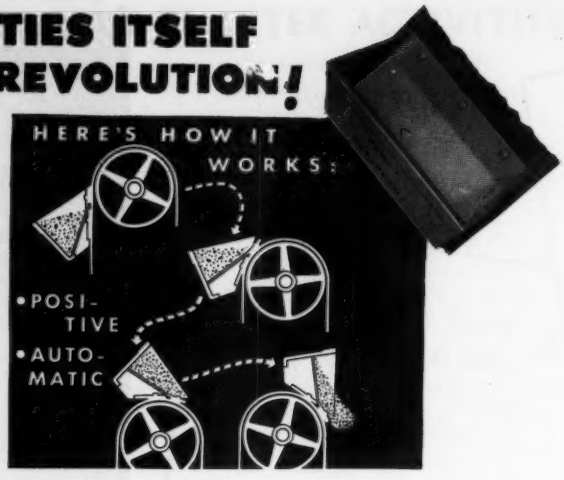

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CHAPTER ACTIVITIES

(Continued from Page 82)

ways, each of which can have a direct affect upon castings made against them."

These words were spoken to Southern California foundrymen by H. E. Henderson, H. C. Macaulay Foundry Co., Berkeley, at the November 14 meeting.

The speaker advised sand men to look at their moisture content when trouble arises. While moisture can vary from 0.3 per cent to 7.0 per cent, the exact amount in any heap is a vital bit of knowledge.

Referring to the old time molder, Mr. Henderson noted how he judged moisture by rule of thumb method which often was surprisingly accurate.

Northwestern Pennsylvania

E. M. Strick
Erie Malleable Iron Co.
Chapter Reporter

C. O. Bartlett, vice-president, C. O. Bartlett & Snow Co., Cleveland, was the speaker for the November 24 meeting of the Northwestern Pennsylvania chapter held at the Moose Club, Erie. Mr. Bartlett spoke on "Modern Ways of Turning Out Castings."

By a number of slides, he clearly demonstrated that no two foundries can use the same equipment and that each one is an engineering problem in itself. He stated that the installation of modern equipment was always looked to as a means of decreasing costs but the trend today is that it is a means of retaining help by making the job easier and the foundry a good, clean place to work. J. W. Clarke, chapter chairman, General Electric Co., Erie, presided and R. J. Stickle, Meadville Malleable Iron Co., Meadville, acted as discussion leader.

The chapter was honored by having as their guests officials from the Bucyrus-Erie Corp., Erie, among whom was Wisconsin chapter Vice-President R. C. Woodward.

On November 14 the chapter staged one of its regional meetings at Dunkirk, N.Y., with 147 in attendance. L. P. Robinson, sales manager, Werner G. Smith Co., Cleveland, was the speaker and in his inimitable manner of presenta-

tion, he sent the foundrymen of the territory away talking to themselves. Between the ills of the core room and the ills of running a chicken farm the speaker made one of the most entertaining evenings the chapter has ever had.

J. M. Morrison, U. S. Radiator Corp., Dunkirk, acted as chairman of the meeting and also handled the arrangements for the meeting.

Central Michigan

C. C. Sigerfoos
Michigan State College
Chapter Reporter

The Central Michigan chapter met on November 25 at the Columbia Hotel, Kalamazoo. Technical speaker of the evening was G. P. Halliwell, director of research, H. Kramer & Co., Chicago. Mr. Halliwell gave an illustrated lecture on the subject of "Non-Ferrous Foundry Practice." The main portion of the lecture was limited to the description of the aluminum bronze and manganese bronze alloys. The phase diagrams and micro-constituents of these alloys were covered in detail with the aid of carefully prepared slides. From these studies, Mr. Halliwell was able to clearly point out that these alloys are very sensitive to minor changes in composition and that to get the desired properties, great care must be taken in the selection and melting of these metals.

In covering practical suggestions for the efficient handling of these alloys, Mr. Halliwell first advised that low pouring temperatures should be maintained.

Central Ohio

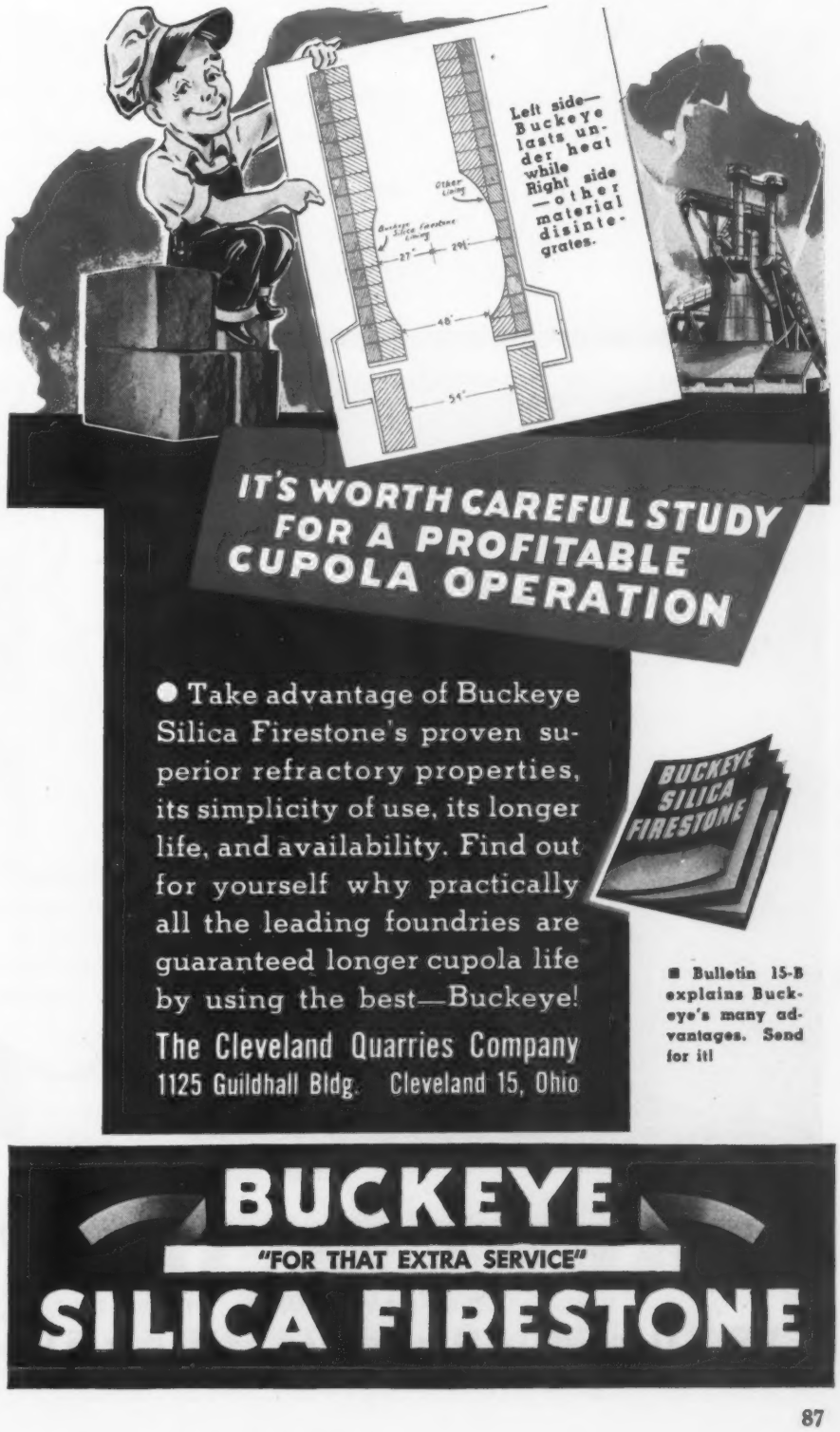
H. W. Lownie, Jr.
Battelle Memorial Institute
Chapter Reporter

The November meeting of the Central Ohio chapter was divided into two technical sessions. Professor H. F. Taylor, Massachusetts Institute of Technology, Cambridge, addressed the steel session on "Gating and Risering," and W. H. White, Jackson Iron & Steel Co., Jackson, Ohio, spoke to the gray iron foundrymen on "Examples of Foundry Troubles and Their Correction."

Professor Taylor confined his illustrated discussion mainly to the risering of steel castings. The use of inert riser compounds, exothermic riser compounds, and insulated

(Concluded on Page 89)

J. S. Vanick, metallurgist, International Nickel Co., New York, speaking at the November 14 meeting of the Eastern Canada & Newfoundland chapter. (For report see November AMERICAN FOUNDRYMAN, *p. 76)*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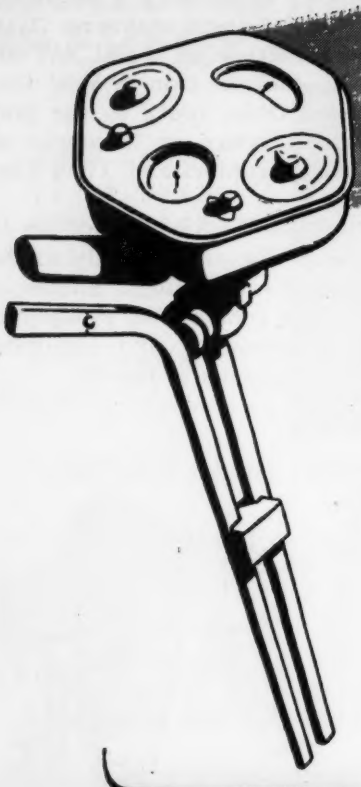

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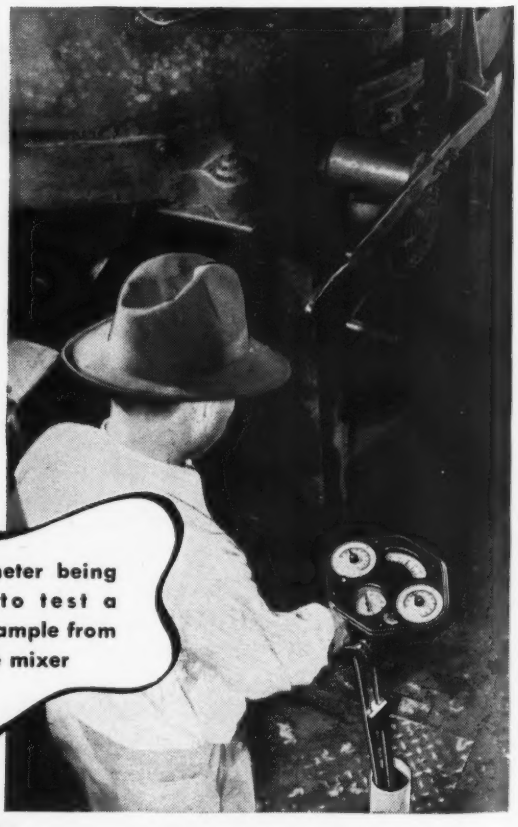
Moistmeter testing moisture of sand on the foundry floor.



Moistmeter being used to test a sand sample from the mixer

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CONTROL

CHAPTER ACTIVITIES

(Continued from Page 87)

risers was shown to offer great possibilities for increasing the yield and improving the soundness of steel castings.

Central Illinois

V. W. Swango
Caterpillar Tractor Co.
Chapter Reporter

The second annual Christmas party was held by the Central Illinois chapter on December 13 at the American Legion Hall, Peoria. This was a ladies night affair, the chapter presenting each lady with a gift. After dinner an entertaining floor show was enjoyed by all.

Twin City

O. J. Myers
Werner G. Smith Co.
Chapter Reporter

The third meeting of the Twin City chapter was held December 4. More than seventy members and guests listened to Ralph A. Clark speak on "Cupola Operation."

Mr. Clark, metallurgist, Electro Metallurgical Co., Chicago, stressed four important factors for foundry men to consider, if consistent iron of proper analysis at lower cost is their objective.

These factors are: (1) type of quality coke; (2) contour of the cupola lining; (3) volume of blast and (4) quality and type of melt materials.

Canton District

N. E. Moore
Wadsworth Testing Laboratory
Chapter Reporter

Canton District chapter, with 135 members and guests present, met at the Swiss Club, Canton, December 11, to hear R. L. Lee, public relations department, General Motors Corp., Detroit, and to participate in Old Timers night.

Mr. Lee emphasized the fact that good management-employe relations are promoted and peak efficiency in operations is attained only when each individual worker is considered as a separate person.

Nineteen foundrymen were presented 50 year service pins in recognition of their services. John Bonnot, Bonnot Co., Canton, received special acclaim for 64 years of service. Awards were presented by C. W. McLaughlin, Lectromelt Casting Co., Barberton.

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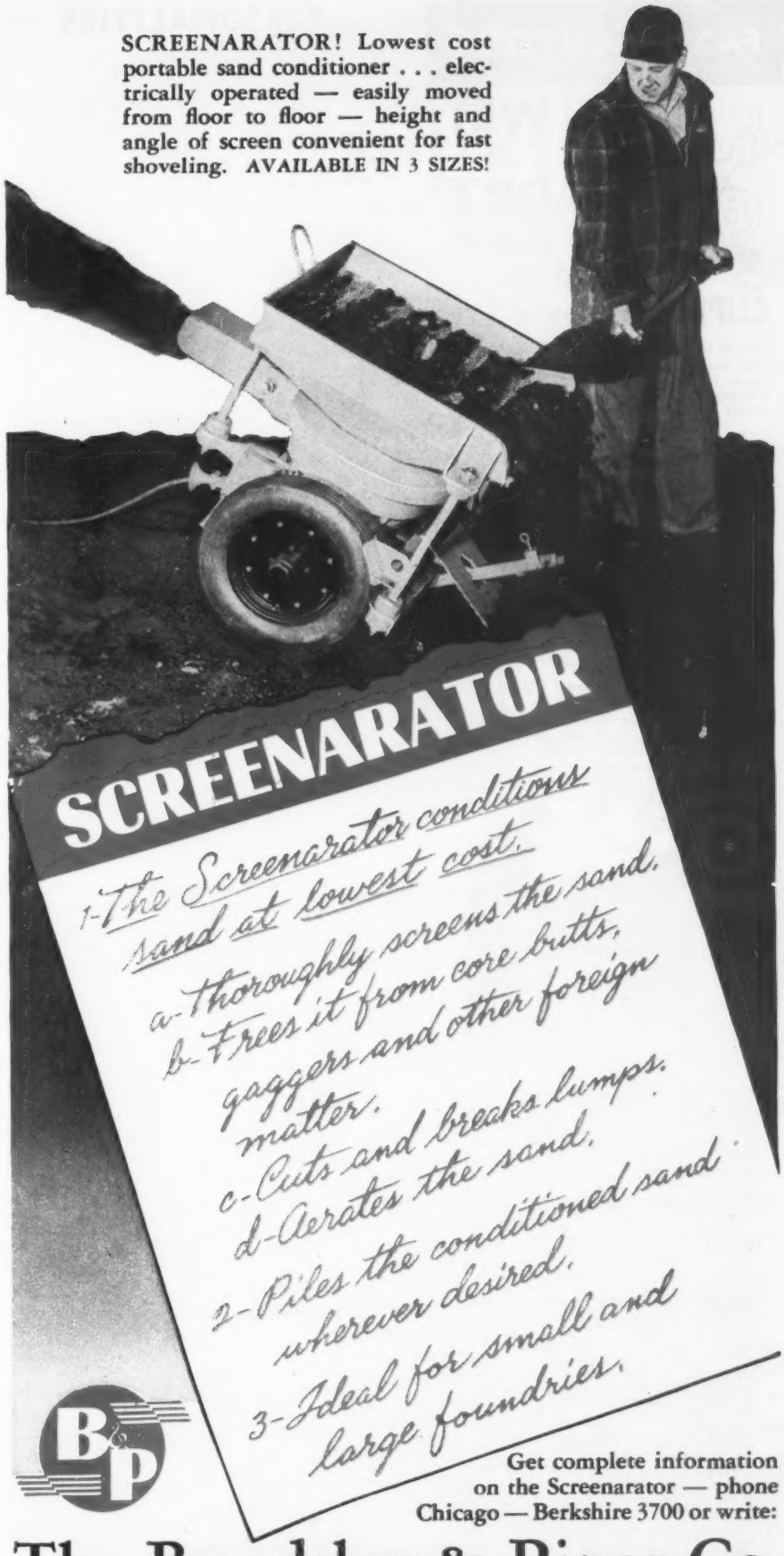
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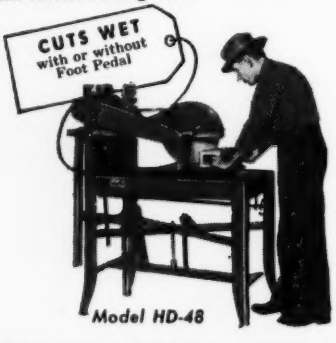

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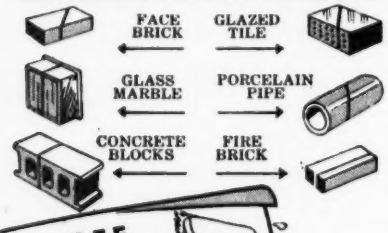

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PERSONALITIES

(*Continued from Page 67*)

effective January 1, 1948. Mr. Walker will assume responsibility for customer relations in the New England territory, with headquarters in Boston. He will succeed **T. S. Knight,** vice-president, who will retire after 44 years of service with the company.

M. H. Blesh has been made manager of manufacturing, **C. B. Bradish,** manager of engineering and **E. A. Green,** manager of sales, General Electric Co., Apparatus Department, Schenectady, N.Y.

Mr. Blesh joined the company in 1928 and is a graduate of the GE Factory Training Course. He has been superintendent of the Control Division since 1944.

Mr. Bradish has been assistant designing engineer, Control Division, since 1924 and has been with GE since 1912.

Joining GE in 1924, Mr. Green has worked on the Test Course, Industrial Engineering Division and Motor Division.

Theodoro Niemeyer, foundry manager, Fundicao de Aco, Sao Caetano, Brazil, was a recent visitor at a Northeastern Ohio chapter meeting in Cleveland. Mr. Niemeyer is in this country studying methods of steel foundry mechanization.

J. M. Morrow has been appointed vice-president in charge of sales, Dayton Steel Foundry Co., Dayton, Ohio. Mr. Morrow has been associated with the company for the past 20 years in a sales capacity.

Two men recently honored by ASME at its Annual Meeting in Atlantic City were **Dr. Raymond C. Martinelli** and **Dr. Jacob P. Den Hartog.** Dr. Martinelli, associate professor of mechanical engineering, University of California, Los Angeles, was awarded the Melville Medal for his paper "Heat Transfer to Molten Metals." The Richards Memorial Award was given to Dr. Den Hartog, professor, department of mechanical engineering, Massachusetts Institute of Technology, Cambridge, for "outstanding work in applied mechanics."

Four new appointments in the General Electric Company's Apparatus Department have been announced: **W. V. O'Brien** has been named assistant general manager of sales, **R. M. Darrin,** manager of central station divisions, succeeding Mr. O'Brien; **J. C. Miller,** assistant to the manager of sales and **H. P. Bish,** manager of Aircraft, Federal and Marine Divisions.

Mr. O'Brien has held various positions with the firm since his affiliation in 1922. He was recently elevated from assistant manager, central station divisions to manager until his present promotion.

Mr. Darrin has obtained experience in

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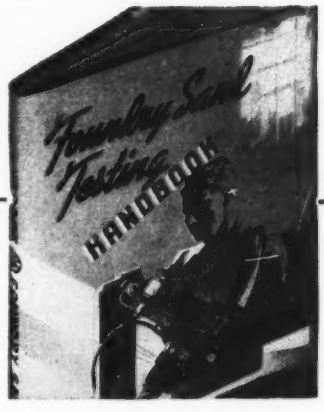

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the Transformer Division and as manager and assistant district manager of company offices.

Joining the firm in 1927, Mr. Miller took the company's business training course and worked his way up to the position of manager, Aviation Divisions, Apparatus Departments.

Mr. Bish has been active in the Federal and Marine Divisions since 1920 and in February, 1927, was appointed assistant manager of the division.

Vice-Admiral George F. Hussey, Jr., USN (Ret.), wartime chief of the Navy's Bureau of Ordnance, Washington, D.C., has assumed the duties of administrative head of the American Standards Association, New York City. In this capacity Admiral Hussey will continue to direct the cooperative efforts of industry, consumers and government in the problem of standardization.

Cyril Ainsworth, who for a number of years has been in charge of the technical activities of ASA, will serve with the admiral as director of operations of the ASA staff.

Ernest L. Gartner, manager, metal and ore division, Du Pont Company's Grasselli Chemicals Department, retired at the age of 67, after 43 years with the company. Mr. Gartner is an authority on zinc and other metals. During the war he was a member of WPB, advisory committees on zinc and cadmium.

Chester K. Fisher, president, Fisher Scientific Co., Pittsburgh, has been chosen as the 1947 recipient of the Pittsburgh Award, bestowed annually by the Pittsburgh section, American Chemical Society. Mr. Fisher was cited for "outstanding contributions to chemistry in the Pittsburgh area."

Eugene A. Lindemann, president, A. J. Lindemann & Hoverson Co., Milwaukee, has been elected a director of Ampco Metal Inc., Milwaukee. He succeeds the late **Samuel E. Schefrin.**

Henry S. Doty, formerly manager of the Kyanite Products Corp. is president; **L. G. Wilson** is vice-president and treasurer; and **N. K. Karchner** is vice-president in charge of production.

Reeve Hoover, Washington, D.C., has been elected chairman of the board, Commercialores, Inc. This organization was established last March by a private group, for the purpose of developing a large kyanite deposit in South Carolina.

George F. Bluth has been appointed director of manufacturing facilities and

(*Concluded on Page 93*)

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bringing together facts to help practical foundrymen eliminate

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CAUSES OF CASTING DEFECTS

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*Originally intended primarily for gray iron founders and prepared by men principally associated with the gray iron field, this book contains valuable information for all foundrymen.

*Every defective casting represents financial loss to the foundry producing it—a clear understanding of the causes of defects, therefore, is of paramount importance to every foundryman.

"Analysis of Casting Defects," a report of the research program of the Castings Defects Committee, is a detailed study on the prevention of casting defects, discarding the out-dated belief that carelessness is the chief reason for defective castings—101 figures clearly illustrate typical casting defects. It is only through elimination of controllable factors that intelligent constructive steps can be taken to modify production methods and materials in order to correct a specific defect.

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PERSONALITIES

(Continued from Page 91)

methods, Willys-Overland Motors, Toledo, Ohio. Prior to his present appointment, Mr. Bluth served successively as assistant general chief inspector, general chief inspector, assistant works manager, and then works manager at Willy's-Overland.

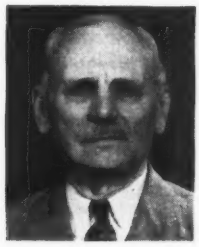
Appointment of **P. L. Edwards** as assistant manager, central district office, Pittsburgh, Raybestos-Manhattan Inc., Manhattan Rubber Div., Passaic, N.J., has been announced. Mr. Edwards, who has been manager of the products division, Manhattan's western district office, started with the company 29 years ago.

Albert Musschoot, a member of the general engineering staff, Link-Belt Co., Philadelphia, has been appointed assistant to the chief engineer with headquarters at the company's excutive office in Chicago. Mr. Musschoot is a mechanical engineering graduate of M. I. T., 1936.

Dr. William F. Meggers, chief of the spectroscopy section, United States Bureau of Standards, Washington, D.C., was recently awarded the Frederick Ives Medal of the Optical Society of America for distinguished work in optics.

Obituaries

A. E. Harrison, 81, a Past National A.F.A. Director and a retired Allis-Chalmers Mfg. Co. executive, died December 2 in Hollywood, Calif. He began working with the E. P. Allis company at the old Reliance works in 1881 as a pattern maker apprentice, and later became foreman of the pattern shops. At the time of his retirement in 1934 he was general superintendent of foundries. Mr. Harrison was elected a Director of American Foundrymen's Association in 1934 and resigned the same year upon his retirement from active business.

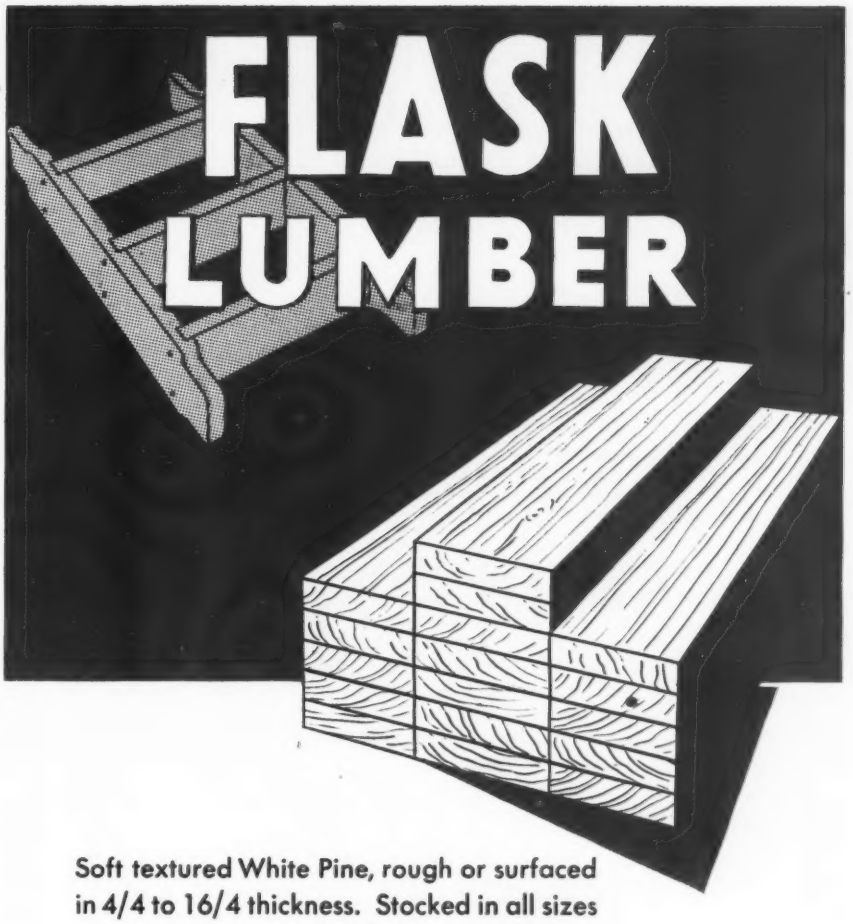


A. E. Harrison

George F. Nye, president, Dobbie Foundry & Machine Co., Niagara Falls, N.Y., died recently at his home at the age of 83. He was a leading figure in Niagara Falls business circles for more than half a century.

Ernest Tyler, foundry superintendent, Canadian Car & Foundry Co., steel division, Longue Point, Que., Canada, died recently at the age of 61. He joined the company in 1910 as an apprentice.

Col. H. R. Lynn, president, Lynn MacLeod Metallurgy Ltd., Thetford Mines, Que., Canada, died recently.



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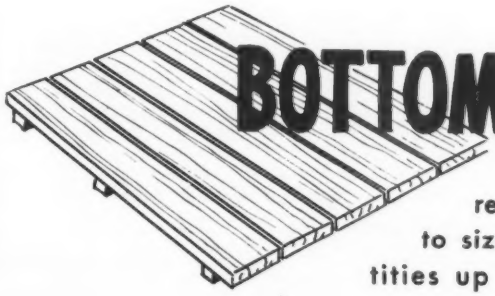

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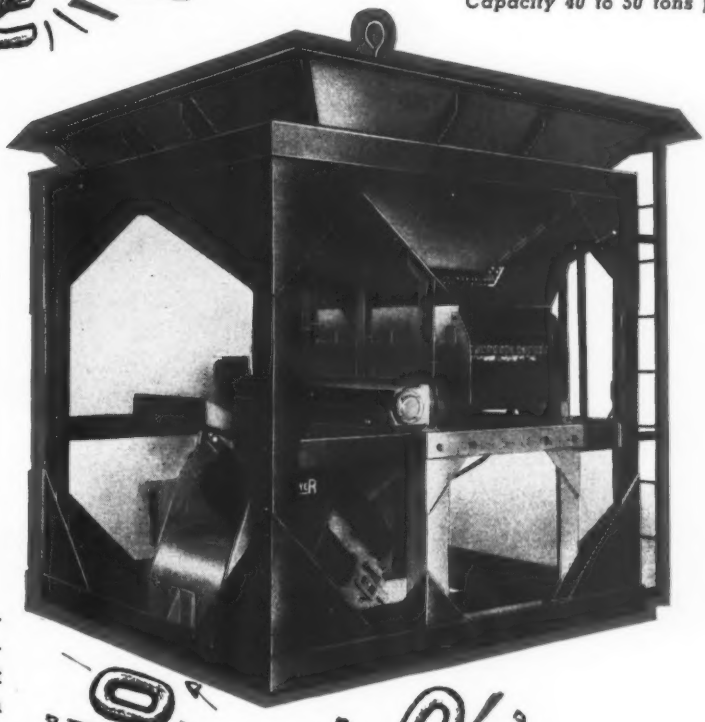

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Free molders and other Foundry personnel for more productive duties—prepare molding sand in half the time at half the cost. The Royer Combination Scrap Remover and Sand Separator and Blender removes larger scrap first; then performs all six of the necessary functions for correct sand separation at one and the same time: removes smaller trash; blends, mixes old sand with new sand and bond; distributes moisture evenly, increases permeability from 10 to 20 points; and double aerates. The fine, velvety molding sand produced pays off in finer finished castings, increased customer satisfaction and more orders.

Increase production output and make extra profits at the one point where both are easiest to accomplish: the preparation of molding sand. Get more sand output per man-hour, lower cleaning room costs, reduce riddling time, slash discount and discard losses. Many models available. Send for Bulletin 744.

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they cure "YAWNING" on the job...

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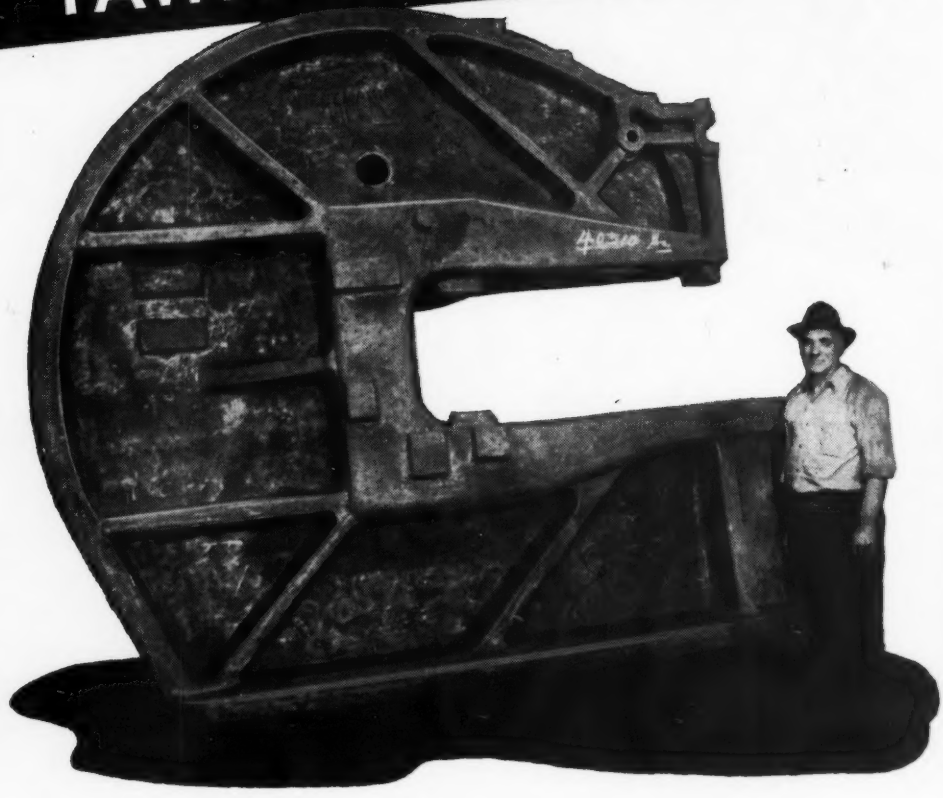

"Yawn" or "give" in a cast machine part often spells rejects for the machine user.

No ordinary cast iron solves this problem, because the low elastic modulus of unalloyed iron under heavy stresses frequently permits dimensional changes.

But..."give" can be reduced to a negligible minimum.

In the 20-ton casting shown above, produced by Schneider Bowman Company, Inc., Philadelphia, Pa., for a large punch press made by Wiedemann Machine Company of Philadelphia..."give" was minimized by casting this part in iron containing 1.50 percent Nickel.

Developing 45,000 pounds per square inch tensile strength in heavy sections, this casting exemplifies the high elastic modulus and strength obtainable with Nickel cast iron.

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IN THE MACHINE SHOP—
Nickel cast irons provide strong, readily machinable castings that take a smooth finish.

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EMBLEM OF INCO SERVICE
TRADE MARK

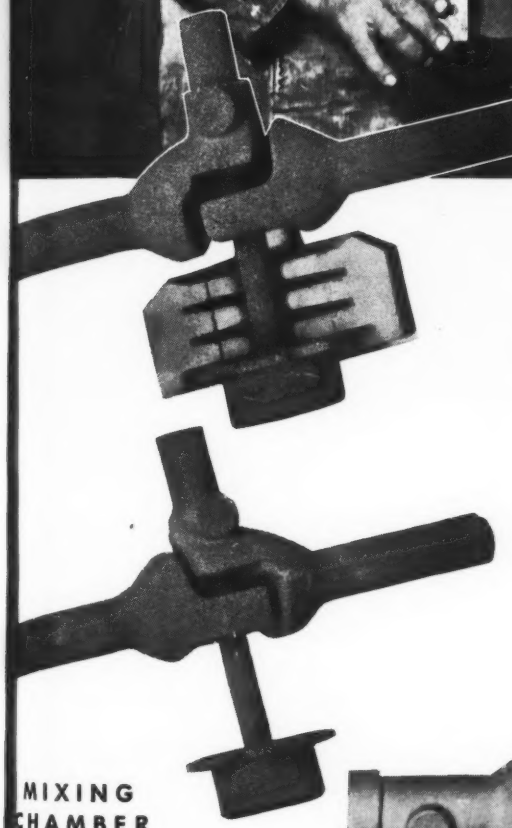
Over the years, International Nickel has accumulated a fund of useful information on the selection, fabrication, treatment and performance of engineering alloy steels, stainless steels, cast irons, copper-base and other alloys containing Nickel. This information is yours for the asking. Write for "List A" of available publications.

THE INTERNATIONAL NICKEL COMPANY, INC.

67 WALL STREET
NEW YORK 5, N. Y.

SO FREE AND EASY ON THE DRAW

THE GLUNTZ BRASS AND ALUMINUM FOUNDRY CO., CLEVELAND, OHIO



MIXING CHAMBER CORES

Notice the clean, sharp edges on every one of these valve body cores as Core Boss John Trohan deftly draws a core. Each was smoothly blown and cleanly drawn—not a second, not a cent wasted by stickiness. Examine the accompanying cores for even bake and sturdiness—all marks of good practice and good oil.

"We bake cores of all sizes in the same ovens", says Mr. Trohan. "The cores stand the heat better with LINOIL and we are always sure of strong cores".

This year GLUNTZ BRASS AND ALUMINUM FOUNDRY celebrates 25 years of producing sound castings. For economy and dependable cores, their quarter century of experience rules in favor of LINOIL.

LINOIL

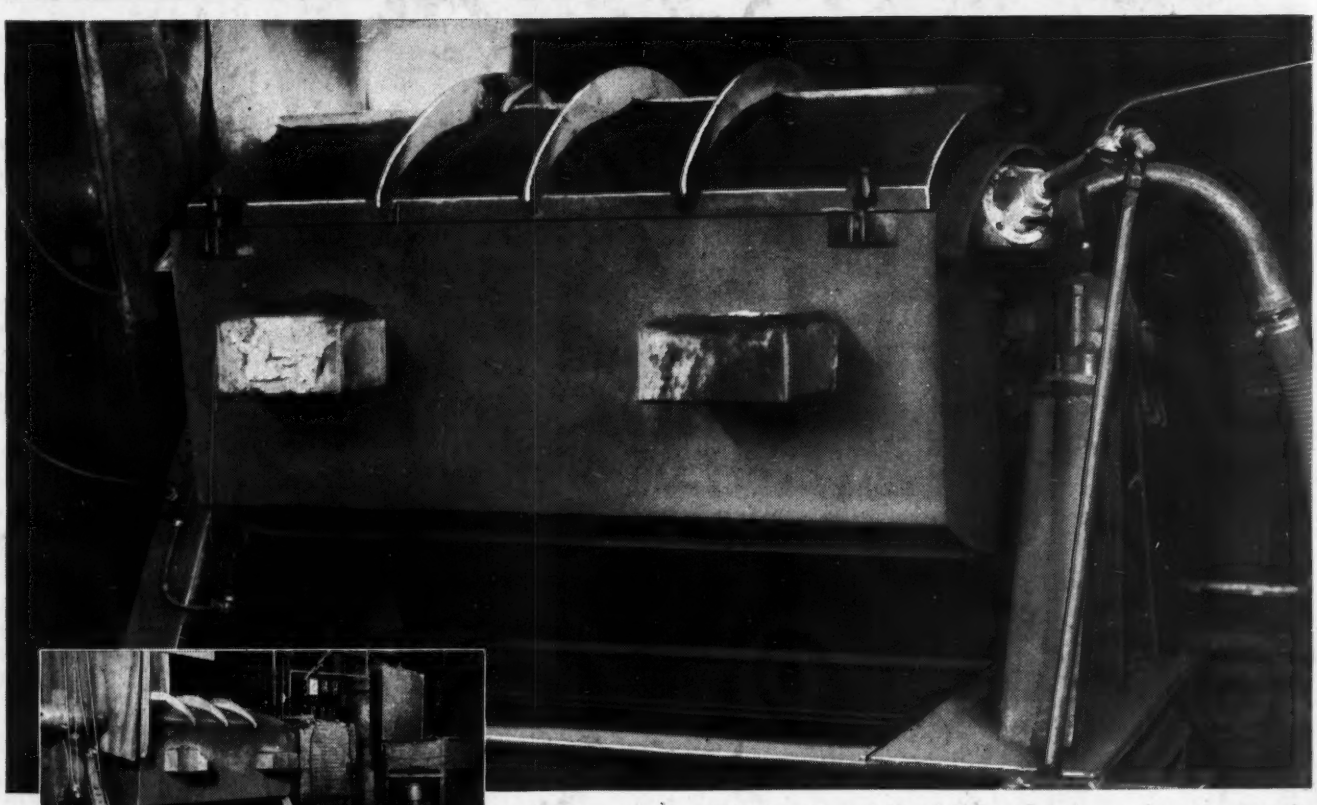
THE WERNER G. SMITH COMPANY

(DIVISION OF ARCHER-DANIELS-MIDLAND COMPANY)

2191 WEST 110th STREET CLEVELAND 2, OHIO

Whiting 3-Ton Heated Metal Mixer

FIRED WITH PULVERIZED COAL



Close-up of 3-ton Whiting Heated Metal Mixer showing molten metal intake (right) and slagging spout (left). Larger units also available.

At extreme right is the coal feed hopper and Whiting #1 Pulverizer.

Front of the Heated Metal Mixer shows the pouring spout.

WHITING
CORPORATION

15628 Lathrop Avenue, Harvey, Illinois

Offices in Chicago, Cincinnati, Detroit, Los Angeles, New York, Philadelphia, Pittsburgh, and St. Louis. Agents in other principal cities. Canadian Subsidiary: Whiting Corporation (Canada) Ltd., Toronto, Ontario. Export Department: 30 Church St., New York 7, N.Y.